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ROENTGENOLOGY AS A SPECIALTY

CALDWELL LECTURE, 1931*

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IT IS a source of great joy and pride to me to be permitted to present the Caldwell Lecture before this distinguished Society. I am sincerely grateful for the distinction of being one of the few who have been deemed worthy of being chosen for this task which is the outstanding feature of your meeting.

I deem it a particular privilege after a lapse of twenty-one years again to be in your midst, a guest of your great scientific Society of which I have the honor of having been a member for the last twenty-five years. But above all it is a source of great satisfaction to me to speak in memory of the man whom during his lifetime we loved and admired as few others and for whom we have preserved our love and respect even after his death.

I hope I may be pardoned for mentioning a curious coincidence which has come to mind. Two decades ago it was my privilege to bring together our late lamented friend, Eugene Caldwell and our present President, Leopold Jaches. Inscrutable are the ways of Providence; I had to come from Hamburg so that these two New Yorkers might meet!

The choice of the subject for my address "Roentgenology as a Specialty," which in part is due to your suggestion, is also based to a great extent upon the fact that it was a favorite one of Caldwell's. He gave it much thought and felt very apprehensive about the future of the roentgenologist.

In attempting to treat this subject, I fear that I shall tell you nothing new, inasmuch as these questions have occupied all of us more or less for many, many years. But worst of all, not having the gift of prophecy, I am unable to foretell the outcome. This much I know, however, that everywhere, in all lands, we must with all our might stem the tide of retrogression and prevent the decline of our specialty. Upon us rests the great and heavy responsibility to future generations for the further proper development of the science of roentgenology.

I propose to demonstrate that roentgenology is a medical specialty, and that the roentgenologist is a medical specialist. Roentgenology comprises diagnosis and roentgen therapy. If this specialist, in addition to roentgen therapy also practises curie therapy, he is a radiologist and his specialty is designated radiology.

Immediately after the epoch-making discovery of the roentgen rays, the technical side predominated. The physician not hav-

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ing sufficient training in physics turned for assistance to the physicist or to the mechanic and, if he knew nothing of photography, to the photographer as well. Soon enough, however, it became evident that one could not get very far this way; the "pictures" were not easy of interpretation, and serious errors were the result. Very soon a few physicians took up this work with great zeal, they made efforts to grasp the technical part and attempted to understand the "pictures." Many of these physicians gave up their previous specialty, devoted themselves entirely to this new field, and became prominent in it. Roentgenology thus developed primarily as a specialty. The technical difficulties which beset us in the beginning are undoubtedly the reason why even today technique in roentgenology is overestimated and placed in the foreground by so many critics, either consciously or subconsciously, while the really more important medical aspect is overlooked as unimportant. An injury to the specialty of roentgenology which persists to some extent today is the unfortunate original association with the photographer, and the absolutely false but seemingly ineradicable conception of the similarity of a roentgenogram to the reproduction of an image by reflected light. This most erroneous of all conceptions of roentgenology as a species of photography to this day degrades our specialty in the eyes of the laity and of numerous physicians who do not want to see or understand that it has nothing, absolutely nothing, in common with photography, except the employment of a sensitive emulsion.

It is this erroneous comparison with photography which misleads the inexperienced to the unjustifiable assumption that he can quite naturally interpret "pictures" of the normal or pathological anatomy of man with which he ought to be familiar in view of his general medical knowledge. The difficulty of the diagnostic evaluation of the roentgenograms was underestimated, and the fact that a general knowledge of medicine was insufficient for the interpretation of the "pictures," especially if it should compare favorably with the autopsy findings, was recognized only when the mistakes became evident. Experience soon demonstrated that knowledge of osteology, for example, is not sufficient and that "roentgenological osteology" demands an altogether different knowledge of normal variations, anomalies, age differences, etc., than was till then required for the practice of the physician or of the surgeon. Geometric and physical laws had to be taken into consideration. Our problems could be solved only when the physicians in question devoted their entire energy to the new science and collaborated in its development. The physicians who became active in this new field found it necessary to familiarize themselves with the mechanical problems of the apparatus, the physical problems of the exposure technique, the geometric laws of the central projection, and the entirely novel effects of the light which penetrates the body. They soon realized that photographic technique was of minor importance and took up the most difficult task, the attempt at interpretation, with the analysis of the differences in densities as projected upon a plane surface by the rays passing through the body. Thus it happened, and had to happen, that these physicians became specialists, limited themselves to the practice of this new science and attained eminence in it. Some of them who were already in the practice of medicine established private roentgen institutes. In the larger hospitals, assistant physicians (corresponding to the interne in American hospitals) were entrusted with the management and operation of the roentgen-ray room. A great number of these have remained true to this specialty ever since. Many a private institute took a very prominent part in the extraordinary development and in the progress of this specialty, side by side with the research work carried on in the roentgen laboratories of those hospitals which place roentgenologically well-trained physicians in charge thereof.

Slowly, but steadily and firmly, this specialty grew broader and broader in its application. While at first roentgenology dealt primarily with foreign bodies and bone injuries, it gradually came more or less in contact with all other branches of medicine. But it remained in the hands of individual physicians whose aid was sought when a roentgen examination or a roentgen treatment appeared indicated. Hospitals and universities sent their assistants to these specialists for training. Even the most rabid antagonist cannot deny that this attitude of the hospitals and universities can be interpreted only as the development and recognition of a specialty. The relative costliness of the necessary apparatus, the large space required, the time involved, and the technical skill which was so essential in the early days, all these factors combined to make this the work of relatively few. (It will be shown later that the far-reaching simplifications of the technique resulting from the competition among manufacturers has greatly lessened the respect for our specialty.) In the early years a certain measure of skill was required for the production of good roentgenograms and therefore evoked a fair degree of admiration and recognition on the part of our medical colleagues. But now that good technique is no more the sole possession of a few, our work is deprecated. Much less respect is paid to the principal thing—diagnostic ability.

The position of the roentgenologist varied in different countries and in different localities within them. Although Americans, in particular, complained during the first decade of a lack of recognition, I have nevertheless the impression that much depended upon personality, and that the physician who insisted upon being consulted as a physician and who again and again very courteously, but firmly refused "to make x-ray pictures to order" maintained his position among his colleagues. Later on I shall attempt to explain why it is so difficult to establish for ourselves among the lay clientele the position due us without getting into difficulties with our colleagues.

The specialized quality of our work is further attested to by the formation of large medico-scientific societies by scientifically trained specialists and by the creation of our own great journals which not only did not disappear quickly, but, on the contrary, increased in number and extent, although all other medical journals are publishing more and more papers of roentgenologic import.

The development of roentgenology made very rapid progress, unusually rapid and stormy for a branch of science, because a good deal had to be learned, experiences had to be correlated and the science had to be built up. Owing to the absence of all organized direction—the specialty developed at first autodidactically and empirically—there was lack of unity. Depending upon individual inclination, extraneous circumstances and temporary influences, the divisions and limitations varied. In one place diagnosis was given preference, in another therapy, in a third both were practised, in a fourth curie therapy was added, and in still others the borderline was widened to include other forms of radiation.

Its development in some places was, of course, not in line with its nature and requirements. In many of them the difficulties and sources of error were not appreciated—a standpoint still prevailing today—and the analysis of the pathological was begun before even an attempt had been made to study and to recognize the normal and its variations, and the anomalies. Thus much confusion was caused by the "pictorial" representation which again and again tempts one to underestimate the difficulties.

In retrospect one realizes that a grave mistake was made in that authoritative bodies, particularly the universities, did not assume the leadership, and that we neglected to bring order into the training of the specialists, into roentgenologic instruction, into its medical practice.

The development of roentgenology was allowed to take its own course unaided.

Thus it happened that in some institutes good, even excellent work was done, that is, in those places where some sort of a school developed out of the tradition resulting from the guidance of an outstanding personality; in other places, however, the level of accomplishment was mediocre, even bad, or took an uneven course. The required high level which should be the goal of all of us is attained only in institutions where, and only as long as, the chief devotes his entire energy or at least most of it, to this field, in other words, where he is a specialist. This holds as true today as ever.

In many institutions roentgenology and radiology rose to great heights and inspired all other medical specialties and in turn were inspired by them, particularly in those places where, with a full recognition of the peculiarities and of the importance of roentgenology, a close cooperation with the clinical specialties was maintained. In others, however, the work became superficial and deteriorated, which may in part have been caused by its rapid expansion and the rapidly increasing new fields of application. Of course, lack of time and money may have played a detrimental rôle. It would be interesting to study particulars and to bring out the differences between large and small cities, between city and country, and to show the variations in the processes of development in the various countries. In this respect one could hardly avoid casting an admiring, nay an envious, glance at Sweden where, in addition to the domination of personality, density of population and the type of its settlement have exerted a lasting influence. It would, however, greatly exceed the limits of this paper if an attempt were made to enumerate the advantages, but particularly the disadvantages and mistakes, in individual countries and states, and to do them justice in a critical survey. I shall, therefore, deal with this subject in more general terms.

The harm, however, which resulted from a too rapid expansion of the art and the consequent faulty, insufficiently prepared training, was not the worst. This could, if the will were present, be minimized or even eliminated. Much more disastrous was the fact that incompetent and dishonest elements grasped this specialty. These, in some instances, were unscrupulous physicians who were guided merely by the expected pecuniary advantages and who, unhampered by clinical and roentgenological knowledge and experience, "sold x-ray pictures," paying the referring physician rebates or commissions, or tempting him by allowing a percentage of the fee. In other instances laymen, with or without the connivance of dishonest physicians, saw in the purchase of x-ray apparatus a get-rich-quick scheme at the expense of innocent patients. Impossible though it may seem, it is nevertheless true that these phenomena caused lasting injury to honest specialism, directly as well as indirectly, and that they are possible only because there are physicians who would do anything but consult another physician. In passing I may mention that there existed unscrupulous individuals who unloaded poor apparatus on the inexperienced physicians.

For these reasons roentgenology suffered a setback, and an injurious effect on its development as a specialty was quite evident. Roentgenology as a whole was blamed for occasional abuses by individuals, and opposition arose to the general recognition of the specialty. All this was only possible because of the erroneous conception in lay and medical circles who saw, or wanted to see, in the medico-scientific activities of roentgenologists merely a demonstration of photographic technique. I am afraid that this erroneous conception has been given support by the peculiar adjustment of the price lists of roentgen-ray work.

Even in hospitals and clinics the development of roentgenology was by no means favorable or desirable. A rapid change in personnel without the fixed point of unified expert direction was bad enough. But it was much worse when hospital administrations, in their attempts to turn the roentgen

laboratory into a source of income for the entire institution, began to practice economy by refusing to place a properly trained roentgenologist in charge of the department, believing that they could get along with a technician competent to handle the apparatus. It need not be emphasized here that even the most efficient roentgen technician who is capable of producing the best roentgenograms can as little take the place of the well-trained medical roentgenologist as a good operating room nurse or orderly can supplant the surgeon. Whoever thinks that this comparison is odious does not go to the root of things; even a hospital medical staff without surgical or roentgenological training cannot obtain results of high quality without the surgeon or the roentgenologist.

The parallel between surgery and roentgenology as specialties is drawn purposely in view of the fact that both have many things in common, such as, for example, their penetration into many borderline fields, their integral interdependence on many other branches, and the peculiarities of their methods of work which require special apparatus, special rooms and accommodations, etc.

I shall come back again to the influence of the insurance carriers. I may now say this much, however, that conditions beyond our control compelled us to separate the expense of the technical procedure from the physician's fee. I have always opposed this procedure in favor of an all inclusive fee which is graded according to the part examined and in which the expenses are included. I shall not enter into a detailed discussion of the pros and cons of a separation of the fees into cost of production and honorarium, I merely wish to point out its disadvantages. A charge based upon the number and size of the films resurrects the unhealthy comparison with a technical trade, with the photographer, and forces into the background the purely medical knowledge and skill involved in roentgen diagnosis or treatment. Over and over again a portion of the medical profession consciously or perhaps rather subconsciously makes the roentgenologist feel how little he is thought of. A patient is referred for a "roentgen picture," sometimes even with specific technical directions "how to take it" instead of being sent for a roentgen examination in order to clarify this or the other clinical problem. It is generally quite immaterial to patient or physician who makes the "picture" because they do not realize that it is only the medical knowledge of the roentgenologist which is the decisive factor. Intentionally or unintentionally the idea is suggested to the patient that the referring physician afterwards diagnoses the disease from the "picture." The patient shall by no means learn that there are certain things which his physician does *not* know. It is for this reason that occasions will arise when the patient is of the opinion that he owns the "picture for which he has paid."

Our specialty must not be made to suffer because physicians who are insufficiently prepared clinically have taken up roentgenology. It is our misfortune that mistaken diagnoses become evident too rarely and too late, and that it is not only laymen who hold the erroneous opinion that the "x-ray picture" is an incontrovertible fact, a proof, while in reality it is nothing in itself, the correct interpretation, everything. Correct analysis, however, need not in every case be identical with a positive diagnosis. Not every roentgen examination, not every roentgen finding, can lead to a definite diagnosis. Interpretation is by no means easy or obvious, it must be learned laboriously, the greatest difficulty being to gauge the limits of one's own knowledge and skill.

Despite all these difficulties, much undeniably has been accomplished in the entire field of roentgenology. The specialty has risen to great heights, has to its credit an immense volume of scientific work, has demonstrated its indispensability to practically every specialty in medicine, has simplified the methods of daily routine in medical practice. But notwithstanding all

these achievements, it has failed in many lands to attain the necessary recognition as a specialty. The other specialists are not relaxing in their attempts to deprive roentgenology of the ground it has gained, to dislodge it as a specialty. If one remembers how long the other individual medical specialties maintained an attitude of aloofness, and what great effort on the part of roentgenology it required to prove to them how much their own work would be enhanced by competent roentgenologic cooperation, one cannot blame roentgenology if now it defends itself against being dislodged and makes every effort to prove and to defend its right to exist as a specialty. The reproach occasionally made that we are attempting to establish a monopoly is so absurd and shows such petty spirit that it may justly be ignored. The aim of roentgenology is to maintain the highest standards, to encourage research and to hand down the acquired knowledge to the rising generation. That this cannot be accomplished as a sideline or through subordinates, the future course of events will prove even to those who have not yet been convinced by an unbiased survey of international roentgenology. The rise of our specialty will and must come even though at present it may seem to be retarded. If it does not come, roentgenology will perish, a calamity which the future cannot and will not permit, because roentgenology has become indispensable, especially if it is of the highest quality.

Practical considerations made imperative the development of roentgenology as a specialty. No one can logically deny that this course of events has satisfied the needs of medical practice. It is true that the universities have not promoted this development; on the contrary, they have remained aloof and even today have fallen into line in only very few countries, at the head of which Sweden has stood since 1923.

By and large, the specialty rests on the shoulders of private medical practitioners, upon the leading private roentgen institutes, and upon those hospitals which have placed their own departments under the direction of well-trained roentgenologists. In Germany there is no uniformity in roentgenologic practice at the universities; it is split up and apportioned among the several clinics which has resulted in uneven practice and achievement. Unified preparatory instruction is therefore out of the question. In the United States roentgenological instruction at the universities has been quite general for a decade and a half; in England obligatory courses were substituted for optional ones about five years ago, the most important step being the granting of the Cambridge diploma. In Italian universities properly regulated instruction in roentgenology has been introduced. In Austria, France, Hungary, Belgium, Norway, Russia, and other countries, ordinary and extraordinary professorships (corresponding to full and clinical professorships respectively in the United States) have been created; nevertheless roentgenology is not everywhere universally recognized as an obligatory subject with compulsory examination.

In contradistinction to the United States where every physician can call himself a specialist, Germany has for many years required proof of a three years' special course which is strictly supervised by the medical profession, before permitting one to assume the title of specialist in roentgenology. But even in that country there is no way of preventing a physician without special training from practising roentgenology, and this state of affairs will continue as long as "Kurierfreiheit," that is, the right to practice medicine without a license, exists, permitting every layman to treat the sick, except that he may not take care of those affected with venereal disease or prescribe poisonous drugs. Despite years of effort we have not succeeded in establishing any sort of official permit or license for the management and operation of a roentgen institute, nor have we been able to have roentgen therapy declared analogous to the administration of poisonous drugs, which would eliminate laymen

and untrained physicians from this field. Lately hope seems justified that official regulations will be established imposing upon medical organizations the duty to control their own ranks, so that only properly trained physicians shall practice roentgen diagnosis and radiotherapy. It remains to be seen, however, to what extent opposition in the ranks of the medical profession will succeed in weakening the effect of such regulations.

The scientific "Gesellschaft Deutscher Aerzte and Naturforscher" (Society of German Physicians and Natural Scientists) already in 1923 recognized the right of roentgenology to exist as a separate specialty, through the creation of a separate and complete section, just as the American Medical Association did in 1925.

These recognitions, however, seem to be of no avail in preventing the efforts which with increasing vehemence are lately being made from various directions again to break down the barrier of this distinct specialty, and to hinder its natural and logical development. The war against roentgenology is so general, that one might almost believe it to be justified if the reasons for it were not so easily refutable.

The faculties of German universities still refuse to establish chairs in roentgenology because a decrease rather than an increase in the number of subjects for instruction seems indicated in order to avoid overburdening the students. Careful and unbiased comparative analysis of the various subjects of instruction will show, however, that by no means every subject is more important than roentgenology. But aside from that, I cannot admit that there is a disadvantage in making the study of medicine more difficult. At the present time there is no good reason why the number of physicians should not be reduced, if thereby the quality of their training would be improved. On the other hand, the function of the university is not solely that of teaching students; its duty is also to encourage research, to develop specialties and to train in these specialties the assistants (internes), that is, properly to prepare our successors. Such continuity of instruction can be carried on only by an independent specialist. Today Germany has but two full professorships, of which one is not even completely independent. In all other universities each specialty has its own roentgen institute. It is true that some of these have great achievements to their credit. But a closer scrutiny of even these institutes immediately reveals the fact that, although roentgenology there is subordinate to the controlling specialty, the physician directing the roentgen department devotes his entire time to roentgenology and has given up his activities as clinical assistant. Indeed, many of these roentgen assistants have developed into valuable roentgenologists who merely lack independent status. The chiefs of these clinics in reality, though not in principle, admit the justification of this specialization in that they allow the development of roentgenology to take its natural course. But what shall become of these roentgenologists? They cannot remain "roentgen slaves" all their lives. If they are not fortunate enough to obtain an appointment at one of the few hospitals which employ roentgen specialists for their roentgen institutes, they are compelled to give up roentgenology in order to obtain a position in their old specialty; and, the irony of it, the more vehemently they disclaim knowledge of roentgenology, the better their chances. I could easily prove this statement by mentioning names. But what under these circumstances becomes of tradition, of the passing on of the acquired knowledge and experience? What, above all, becomes of the preparatory instruction in general roentgenology, what becomes of roentgen physics, of roentgen biology, of roentgen anatomy? In individual clinics the practice and development of roentgenology remains limited to that particular narrow field, and consequently its instruction remains one-sided. The clinician cannot teach even the roentgenology of his own specialty because he does not teach the elementals of roentgenology. An individual

clinic might, under certain circumstances, produce high grade scientific special work, which however remains one-sided and does not aid in the advancement of roentgenology. If these specialties should also teach roentgenology applicable to their respective fields we would have numerous roentgenological courses instead of one, and that has already been considered overburdening the student. If a change in personnel occurs, it becomes apparent that everything depended upon one person and disappeared with him. For that reason there is constant need for a new organization which often fails to materialize, if the proper person cannot be found. There is no place where the union of eminent clinician and eminent roentgenologist in one person has existed for a long period. One of the two subjects must suffer because each requires the full time and energy of an individual. The rapid development and the extensive domain of roentgenology require the complete absorption of a person in it, especially if he is anxious to have a part in research and in its further development.

Systematic presentation of roentgenology is, however, necessary, not only for the training of general roentgenologists and of other specialists who wish to learn and practice the roentgenology of their respective fields, but also as a basis for the general knowledge and education of every physician, so that he may become familiar with the possibilities and indications of a subject which has acquired such an all-embracing importance in the practice of medicine. This systematic presentation, however, can be made only by an independent representative of this specialty.

The demand for recognition as a specialty is further justified by the peculiarity of its methods of work which require extremely specialized apparatus and an uninterrupted, continuous, intensive, concentrated training. The claim that roentgenology has become too extensive for a single specialty can with equal justice be made against surgery, internal medicine and perhaps some other specialties.

Our insistence upon an independent representative of our specialty and upon the formation of central research and teaching institutions at the universities does by no means imply that detached independent clinics shall not have their own roentgen laboratories. But of this later.

Opposition against the independence of roentgenology is however not confined to the universities alone. While many large hospitals have recognized the advantages of a central roentgen department under the direction of an independent specialist, there are other hospitals in which the opposition of individual specialties seriously hampers this natural development. The representatives of other specialties believe that they must have their own roentgen laboratories, so as to avoid a separation of the roentgen examination from the clinical examination as a whole. But none of these specialties connected with large hospitals makes its own pathologico-anatomic, serologic and bacteriologic examinations wherever independent laboratories for such examinations exist. And for that matter these specialists do not in the long run make the roentgen examinations themselves, but entrust this work to an assistant who is compelled to devote his entire time to it. Thus the clinician himself confirms the need for specialization, a phenomenon which we have observed at the universities. Nobody seems to take into account the rising cost, the waste which results from the multiplication of the roentgen equipment in one and the same hospital. This item of expense is increased still more by the lack of unified direction brought about by the frequent change of assistants and the influence of distributors of apparatus. It is an absolutely mistaken notion to assume that under such circumstances roentgen diagnosis fits better into the general scheme of clinical diagnosis because both are practised by the same individual; even with the best of intentions a subordination of roentgenology cannot possibly be avoided. There can be no doubt that the objectivity of the roentgen findings is better guarded by the

roentgen specialist who is not influenced by a clinical preconception; it goes without saying, however, that the closest cooperation between clinician and roentgenologist is absolutely essential to obtain the best results. Roentgenology practised exclusively by the various individual clinical specialties would bring about the most unfavorable solution of the entire problem because such a practice would produce the most irregular, uneven and inconsistent results. It is only a very limited number of practitioners of the other specialties who would have the time, the inclination, the innate talent, or the ability required for so highly and so broadly developed a medical method to do it justice equal to their own specialty. Differences of opinion regarding questions of principle, differences in technique, instruction and administration would result to the disadvantage of patient and student. Another important factor to be considered is that individual hospital departments or clinics will find it economically very difficult to keep pace with the development of apparatus which moreover frequently require special quarters, not to mention the constant progress in the development of the methods in the various fields of examination. But not all of these objections apply to a central roentgen institute which is under the unified direction of a roentgen specialist, and which is equipped with adequate special apparatus to satisfy the needs of individual clinics and to carry out the most varied methods of diagnosis and treatment. Even if occasionally a special branch of the roentgen laboratory is directly attached to the operating rooms, the advantages derived from a central roentgen institute are not impaired as long as this special laboratory remains under the control of the central institute.

The opposition to central roentgen institutes under independent chiefs, if successful, will strike our specialty at its most vital spot. How can we expect capable, industrious and ambitious young physicians to show an inclination for the study of roentgenology, to devote themselves to it, when they see that advancement, the attainment of an independent life position are denied them and that their principal occupation will be that of servants of other specialties? How can we with a clear conscience attract the younger men to this specialty, if we can offer them only such uncertain and poor prospects, if their work will be considered a subordinate diagnostic aid and will be valued merely as such?

The denial of the need for roentgen specialists also affects the existence of the private institutes upon which the general medical practitioner must more or less rely. Where shall the roentgen examinations which are constantly required be carried on and by whom? The physicians who deny that roentgenology is an independent specialty ought to have some logical notion of the solution of this question for the near future. If the opinion of those physicians should prevail who, aided and abetted by the propaganda of business-hunting manufacturers, maintain that each practising physician should have in his office an x-ray apparatus, just as he has a stethoscope and a plessimeter, where shall the private roentgen institute secure its clientele? When these laboratories shall have disappeared, where will the general practitioner be able to obtain assistance in case of need? It is absurd to contend that all general practitioners and all clinical specialists may become experienced roentgen diagnosticians and therapists. Furthermore what sort of roentgenology may be expected from the general practitioner? He cannot afford to install large and complete roentgen equipments, because that would not pay, besides he would not be able to operate them or to obtain the utmost service from them. He must therefore be content with small, nay the smallest, apparatus such as are incessantly produced and zealously offered for sale by the manufacturers in their efforts to increase their business. The small apparatus are sufficient for definite purposes and are useful in the hands of the experienced, otherwise they aid in the

production of incapable roentgenologists. When roentgenology will have become universal among the general practitioners the consequent lowering of the demands made upon apparatus and upon the operator's skill and knowledge will result in a deterioration of the quality and in an arrest of the progress and of the development of the art. It is imperative, however, that roentgen diagnosis and therapy be developed to the highest perfection so that it may be of benefit to the patient. We must not be content with incompetent mass production. The advocates of universalized roentgenology must come to a realization of the responsibility which they are assuming by prematurely placing roentgenology in the hands of every general practitioner. The resulting injury may perhaps never be remedied. We roentgenologists, however, who can foresee the consequences must energetically combat the indiscriminate distribution of inferior apparatus and the consequent deterioration of roentgenologic work because ours is the responsibility for the development of roentgenology. The physician must recognize that there is no such thing as "minor roentgenology" in analogy to minor surgery. The difficulties are not readily apparent, the inexperienced does not realize the sources of error, the pitfalls and obstacles which might cause his downfall even in the simplest roentgenogram of a hand or a foot, to the detriment of his patient! The nature of roentgenology is such that secondary or superficial attention to it will not do.

The development and existence of private roentgen institutes is further menaced by the competition of the hospitals whose desire to amortize their equipment leads them to underbidding. They can afford to do so because, in addition to state, municipal, or private charitable support, their general expenditures including cost of space, materials and personnel, are lower or do not have to be figured on by them in their calculations. Development of roentgenology on the score of its ability to pay its way, on the score of cheapness alone, is not the right attitude and is to be deplored, because such an attitude must result in its detriment. It is only the experienced roentgenologist who can hew to the middle path which leads to the maintenance of work of the highest quality. We must refute as nonsensical the contention that the progress of roentgenology lies solely along the path of technical improvement. We must discourage unnecessary refinements in the construction of laboratories and in designing equipment. These are not merely the outcome of competition among manufacturers, but are often due to the personal vanity of some roentgenologist; it is not absolutely necessary that every young assistant shall design or suggest a new examining table or a new modification of a piece of apparatus which for many years has proved its usefulness. Technical equipment is not the deciding factor; medical knowledge and roentgenological experience are much more important. The gun will discharge but it is the marksman who hits the bull's eye. A Schubert elicited from a spinet much greater, more beautiful music than an amateur could from the most expensive concert grand piano.

The constant improvement of apparatus necessary for the progress of the science and art of roentgenology will be achieved more readily, more efficiently, and more cheaply through the collaboration of a few qualified research and teaching institutions than through the numerous small and smallest roentgen laboratories.

Finally there must be mentioned an additional factor which is detrimental to roentgen institutes, namely, the organization by certain groups of insurance carriers of their own roentgen laboratories. This, to my mind, is not the place to discuss in detail the reasons for this by-product. I shall, therefore, leave unanswered the question as to what considerations prevailed, in how far it was brought about by the desire for political power, or by the expectation of economy, that is, the reduction of the enormously increasing operating costs of this constantly expanding specialty. I shall also

refrain from examining as to who committed the serious mistake of sacrificing a portion of the free practising profession, a mistake which today seems irreparable. The favorite argument of the opposition is that, attracted by the expectation of large incomes, too many poorly trained physicians have taken up roentgenology and have thereby caused its deterioration. Our only means of refuting this argument is by the establishment of rigid requirements in our own ranks and by far-reaching regulations on the part of our medical organizations—at least as long as the university faculties display no interest and remain inactive. It remains to be proved, however, in how far medical organizations are ready, able or willing to protect roentgenology against the demands of the profession for its generalization. But in spite of all this the solution seems to me so extremely simple: Every physician, I repeat *every physician*, may practice roentgenology, if he has acquired an honest, conscientious, adequate training therein, but *only then*.

Let us be frank with ourselves: the insurance carriers desire competent and reliable services in return for their money; if we and our organizations do not see to it that they get it, they will use their present power to capture roentgenology for themselves to the detriment of the universities who will awake too late. Many capable young roentgenologists have already accepted directorships at such institutes because universities and large hospitals are denying them the chance for advancement in independent positions.

In conclusion, I wish emphatically to affirm that there is a way out. We can successfully combat the threatened deterioration of roentgenology, the decline of private institutes, the economic ruin of the properly trained roentgenologist. We can prevent the increase in the number of "apparatus owners" who are becoming a curse to the specialty. There is a road which leads to the recognition of the well-deserved right of the roentgenologist to maintain an independent position in scientific and practical activity, which leads to the recognition of roentgenology as a scientific and medical specialty, which leads to the refutation of the mistaken notion that it is merely a technical expedient. But we must not rely upon help from without, nor upon social and economic readjustments, nor upon regulation by law. We must incessantly educate the doctors and the laity. The power to regain ascendancy is to be found only in our own ranks, we alone can pave the way to the position which we desire for our specialty, and to which it is entitled. The milestones on the road are: the strictest self-discipline, elimination of all unscrupulous elements, the highest development of medical ethics, the highest attainable service in our practice, in scientific research and in teaching. This path is long and steep, but it will lead us to our goal, provided men of character and determination will only take it.

We roentgenologists must always feel, and must let the outside world know, that we are physicians and nothing but physicians. Only those who possess the proper clinical training and background should be permitted to acquire roentgen-diagnostic and roentgen-therapeutic training, others should not be accepted. The time has long passed when knowledge of roentgenology had to be, and could only be acquired autodidactically. Today proper instruction and contact with clinical medicine are essential. In the present state of expansion of the specialty elementary study and systematic instruction are indispensable and cannot be supplanted by mere practical experience. The greater the clinical knowledge of the tyro roentgenologist, the better will be his roentgenologic achievements. The roentgenologist should not lend himself to the giving of short, superficial courses, and should not accept any pupils without clinical preparation. The medical profession must be educated to an appreciation of the man who is competent to practice roentgenology; they must be shown how injurious poor, inefficient and inadequate work may prove to be. We

must, by means of lectures and demonstrations, inculcate into the medical profession a true understanding of roentgenology; they must be made to realize the fact that it is not merely apparatus, but first and last the ability of the roentgenologist in interpreting the roentgenogram which brings about reliable results. Reliable results, however, should not in every case be understood to mean a final diagnosis. Each and every one of us must constantly instruct his colleagues in the possibilities and limitations of, as well as in the indications for, roentgen diagnosis and radiotherapy. The roentgen specialist must make the severest demands upon himself and upon his conscience in his daily work. He must spare neither time nor money in the performance of his daily tasks. Only when his work is of the best will he permanently maintain his position. But then he will maintain it as against the physician who practises it as a side line because the latter cannot do justice to his own specialty and to roentgenology at the same time and will never be able to fully utilize the potentialities of the latter. It is useless, however, to tell him that; he must be convinced by our daily performance. It is the duty of every roentgenologist to submit a written report of his findings in every case examined by him. This report should contain an objective description of the roentgenoscopic and roentgenographic findings and the diagnostic conclusions drawn therefrom. In this report the roentgenologist must give an account of what he saw. His description should contain nothing but what he saw, free of all fancy and sophistry. Such procedure trains one to exactness and conscientiousness, and marks the dividing line between competence, on the one hand, and superficial, unscientific utilization of roentgenologic methods which is undeserving of confidence, on the other. The report should be kept in the roentgenologist's files, together with the roentgenograms and other records. Films should not be given to the patient any more than microscopic sections. To do so is unsound practice. It is also advisable to avoid discussing the films with the patient.

The roentgenologist should consider himself a consulting physician and should insist upon being treated as such. He should make only such examinations as in his opinion will answer the purpose, and should employ radiotherapy only upon proper indications. We must make an end to the practice of unloading all hopeless cases upon the radiological institute. Patients in whom radiotherapy is not indicated should tactfully but firmly be denied treatment. Fictitious irradiations which merely serve as a placebo or are intended to show the patient that something is being done for him, should be strongly deprecated; they discredit this therapeutic method and are unpardonable because of the useless expense to the patient. The mistake made by another physician in holding out hope of a cure or relief through radiotherapy is not and should not be sufficient reason for a dishonest procedure which is apt to arouse expectations that cannot materialize. By the same token the patient should receive no superfluous or useless irradiations.

The method of furnishing a diagnosis requires especial tact. The roentgen findings and the resulting diagnosis should not be given directly to the patient. If the roentgenologist has been consulted by a colleague regarding a roentgen examination, it is self-evident that the result should be discussed orally or in writing as between consultant and physician. It is important to avoid even an unintentional criticism in case of a discrepancy in the results of the clinical and roentgenological examinations, although the credit due to the roentgenologist may be minimized or withheld owing to lack of tact on the part of the referring physician. Even patients who consult the roentgenologist of their own accord and are not referred by another physician, should not be informed of the diagnosis unless there is good reason for it. It has for years been my practice in such cases to ascertain before making the examination the name of the physician who has been attending

the patient till then so that I may know to whom to send the report or with whom to communicate in case of need. Under such circumstances one escapes an embarrassing situation in case of an unexpected cancer and avoids unpleasant discussions which might result from a dissimilarity in terminology that might give the layman the impression of a difference of opinion. On the other hand, the roentgenologist has a right to expect of the referring physician that he impress upon the patient the consultative nature of the roentgen examination.

Permit me to mention here another matter. A roentgenologist will gladly give his opinion and advice to colleagues with whom he is in contact. But it is wrong to make it a practice of asking, as a matter of professional courtesy, for an interpretation of films made by others. The roentgenologist, just as every other physician, must earn his living from his knowledge, and such consultations, whether in the presence or absence of the patient, should be paid for by him. The fewer exceptions to this rule which the roentgenologist makes, the less disrespect will be accorded to his knowledge and ability.

Many of our difficulties could be more readily alleviated through a closer and more rigid organization of roentgenologists. A more intimate cooperation would enable us to exert a greater disciplinary influence upon our own colleagues, and to educate them to the necessity of upholding and defending our active and passive demands, not only against the opposition, but against ourselves as well. Furthermore, we should conduct a more energetic campaign of education among the medical profession to convince them of the advantages and of the great value of high quality roentgenology as compared with the worthlessness, the harmful results of incompetent roentgen work. Perseverance in this propaganda is indeed a grateful task for us. Work of the highest quality, conscientiousness and strict attention to the task in hand when practised in our daily routine will smooth our path.

In Germany we have tried one other means to secure recognition for the adequately trained roentgenologist, namely, by the granting of a diploma. A tentative draft of such a diploma has already been prepared, but as yet there is no authoritative body which, having granted it, would have the requisite power to protect it.

Let me conclude with an appeal that we defend to the utmost our great specialty against all opposition and that, notwithstanding the present dark outlook, we do not relax in our efforts to attain for it the position that is justly its own.

THE RELATION OF COLITIS TO POLYPOSIS OF THE INTESTINE*

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INFLAMMATORY disease in one form or another has long been recognized as a probable etiologic factor in the development of new growths.[5,6] The status of this relationship is well exemplified in the large intestine.

FIG. 1. Polyps of large intestine secondary to chronic ulcerative colitis.

Chronic ulcerative colitis, a severe infectious disease of the large intestine, may leave in its wake, when the major disease heals, a ragged lining of the bowel which appears as if torn to "shreds and tatters." This has been accomplished by the extensive ulceration and necrosis of the colitis. It is not a disease of the mucosa but of the whole wall, and whereas in the wall there are changes resulting in increased diameter and narrowing of lumen, the mucosa may be denuded in a large measure, leaving only tags and islands of inflamed, swollen and hypertrophied tissue. As the intestinal wall heals and new mucous membrane replaces the denuded portions, one of two processes may take place: the new mucosa may extend up and over the residual mucosal tags, or it may grow up to the base of these tags, thus further extruding them into the lumen by a process of pressure and choking. By this and the traction of fecal current, polypoid tumors of considerable size may result (Fig. 1). These may be very numerous, thousands in a single colon, and their multiplicity will bear a direct relationship to the site of the severest ulcerative colitis. This form of polyposis of the large intestine has been called, by some observers, pseudopolyposis, and has been designated by Erdmann and Morris as the adult or acquired type of polyposis. This constitutes the first of the three types that will be considered in this paper, the other two types being the adolescent and senescent. It is generally recognized that chronic ulcerative colitis usually begins in the rectosigmoid portions of the large intestine; hence the greatest number of polyps usually exists here and their numbers vary inversely with their distance from the cecum. The following case is illustrative of the first type of polyposis.

CASE 1. A man, aged twenty, was admitted to The Mayo Clinic September 26, 1925. He had had attacks of bloody dysentery, with a maximum of thirty to forty stools in twenty-four hours, for nineteen months; sometimes the attacks lasted for a hundred days in succession. A diagnosis of amebic dysentery had been made although amoebae had not been found. He was acutely ill, with a maximal temperature of 102° F. The stools were mixed with pus and blood

* Read before the Chicago Roentgen Society, Chicago, Illinois, March 11, 1931.

Incontinence was troublesome. He had lost 24 pounds.

The pulse was 90; the blood pressure was 120 systolic and 90 diastolic, measured in millimeters of mercury. The abdomen was moderately tender. Proctoscopic examination disclosed diffuse, granular involvement of the mucosa of the rectum and sigmoid, edema, a tendency to hemorrhage, and scattered punched-out ulcers. A diagnosis of chronic ulcerative colitis was made. During the next five months the patient's condition fluctuated. Improvement was slow but by October 24, 1925, he was well enough to be dismissed from observation.

The patient returned in February, 1926, more seriously ill than before. He had failed steadily during the month. Proctoscopic examination showed large, sloughing, ragged, undermining ulcers of the rectum with bridging of the mucosa between large ulcers. Ileostomy was suggested as an emergency, but because of the patient's condition it was not done. Treatment then consisted of tincture of iodine by mouth, large doses of kaolin alternating with bismuth, opium and paregoric and small doses of vaccine prepared from the diplostreptococcus which had been isolated in practically pure culture from the ulcers in the rectum on both visits to the Clinic. The patient began to improve slowly and after several months was able to go home.

The patient returned again in September. He had gained 37 pounds in the preceding four months. He was having six to seven bowel movements in twenty-four hours; the stools occasionally contained a little blood and mucus. Proctoscopic examination showed the mucosa to be practically normal; a few pitted scars were scattered over a slightly pale mucosa. There were multiple polyps from 0.3 to 0.7 mm. wide and from 0.3 to 1.5 cm. long; some of these bled easily. Polyposis had followed the healing of advanced chronic ulcerative colitis. Clinically the patient was in excellent condition. He was dismissed with instructions to take vaccine subcutaneously. In May, 1927, he reported that he had had the best winter since the beginning of his illness. He had gained 50 pounds and looked the picture of health. He had averaged three bowel movements daily for months and had not seen blood in his stools for at least a month. Proctoscopic examination now showed that the chronic ulceration of the colon was healed, leaving polypoid areas and polyps. Certain small polyps that were seen in January had disappeared. The mucosa between the polyps was normal except for the scars of the infection. A series of treatments by fulguration of the rectal polyps was carried out without incident. The patient was free from symptoms of bowel trouble but because all of the polyps could not be fulgurated at the first visit, he returned in December, 1927, at which time the proctoscopic examination disclosed several polyps still in the rectum but the mucosa was normal. The polyps were again fulgurated. In August, 1928, there were some scars in the rectum but no ulceration; the lumen was practically normal in diameter and the areas fulgurated were free from polyps.

Fig. 2. Polyps of adolescent or congenital type.

Chronic ulcerative colitis may not be the only inflammatory disease which might become the basis of polyposis. Cases have been reported of polyposis following intestinal tuberculosis and extensive amebic ulceration of the colon. However, both of these diseases are infectious with mucosal involvement primarily, and if they heal they are much less likely to leave extensive

destruction and deformity. Extensive amebic ulceration will usually heal without leaving late evidence of disease in the form of unusual scarring and when tuberculous colitis is extensive it is usually secondary to pulmonary disease and generally fatal. Less severe tuberculous colitis, as pointed out by Brown and Sampson, may heal and in turn produce polypoid disease. However, in comparison to chronic ulcerative colitis this is a rare end-result.

The second, adolescent type (congenital and disseminated) of polyposis is prone to be familial[4] (Fig. 2). I have seen cases of this in children of the first decade of life, and in such cases usually a parent had been similarly afflicted. However, serious symptoms rarely become apparent before the early years of the third decade of life. Hence, most patients present themselves for diagnosis at this time. In this condition one finds numerous disseminated polyps and polypoid projections into the intestinal lumen in the wall of an apparently otherwise normal colon, both from the standpoint of mucosal changes, and size and contour of the lumen. The tumors may be submucosal protrusions of many sizes and dimensions with a mucosal covering, or true adenomatous polyps. They may be so numerous that they literally cover and involve practically the entire mucosa of the large intestine. Many of them may be on pedicles which are sometimes several centimeters long. The dark discoloration often present in their serrated portion clearly distinguishes them grossly from the polyps following colitis. The following case is illustrative.

CASE II. A boy, aged ten, was admitted to The Mayo Clinic, September 18, 1930, complaining of ulcers of the bowel. His father had died recently at the age of thirty-one years, following colectomy for multiple polyposis of the bowel. The paternal grandfather and one uncle had died of tumors of the bowel. The grandfather had died in the thirties. The patient had not had any brothers or sisters. The mother stated that the child had never had a formed bowel movement. The bowels had always been loose and at the time of admission they moved four or five times daily. Blood or mucus had never been noted in the stools.

The boy appeared to be well developed and well nourished. He had two deciduous teeth. Rectal examination revealed many small polypoid growths in the lower part of the bowel. Urinalysis, the Wassermann reaction of the blood and the von Pirquet test were negative. The hemoglobin was 13.7 gm. in each 100 c.c. by the photo-electric method; erythrocytes numbered 4,550,000, and leucocytes 7,800, with lymphocytes 20.5 per cent, transitionals 3.5 per cent, neutrophils 74.0 per cent, eosinophils 0.5 per cent, and basophils 1.5 per cent. The stool contained *Chilomastix mesnili*, *Endamoeba coli* and erythrocytes. Proctoscopic examination showed the entire mucosa of the rectum and sigmoid studded with polyps as far as could be seen. A roentgenogram showed generalized polyposis involving the entire colon and apparently the terminal portion of the ileum. Multiple polyposis of the colon and probably of part of the small intestine was diagnosed. Radical operation was advised but was declined.

A third type of adenomatous polyp of the colon, pathologically probably similar to or indistinguishable from the adolescent type, occurs in late adult life, during the period of senescent or degenerative change. These polyps may be single or at least relatively few in number. They may occur as definite benign lesions in any portion of the large intestine and often in close proximity to a malignant neoplasm. At times a single adenomatous polyp may present apparently benign changes in one region of its serrated portion and typical carcinomatous change in another. Or, as FitzGibbon and Rankin have shown, advanced, high-grade adenocarcinoma may exist in a short piece of mucosa of the colon, and near it may be all gradations of polyps from the standpoint of size, as well as varying stages of neoplastic change. These pathologic data, then, form the basis of roentgenologic descriptions.

The clinical relationships among these three types of polyposis of the large intestine are also clearly on the pathologic basis. In the group of cases in which colitis has definitely been established as the patho-

logic basis of the polyposis, the diagnosis should be readily established. That some inflammatory disease may play a part in the origin of the second type still remains within the realm of possibility and that inflammation or irritation plays a part in the third type is probable.

Carefully taken anamnesis, then, is the basis of proper diagnosis. The history of recurrent bloody dysentery or recurrent and continuous bloody purulent rectal discharges over a period of months and years, with severe acute exacerbations at times, practically determines the diagnosis of chronic ulcerative colitis. The disease may occur at any age but most commonly in the third and fourth decades. The familial tendency of the second type, the age incidence, and the absence of noteworthy former intestinal disease are often suggestive of the type of polyposis.

The general examination of the patient is not always diagnostic. It is true that impressions are gained from a patient's general appearance, loss of weight, and usual pallor from anemia and general debility, but these could be features of any serious intestinal disorder.

Digital rectal examination cannot be overrated as a diagnostic aid. In chronic ulcerative colitis with polyposis the rectal lumen is narrowed, the wall is resistant and lack of resiliency is noted. Studding this tube-like rectum, numerous irregular, sometimes nodular, projections are palpated.

In the second type the lumen is usually normal in size, the soft, velvety, pliable mucosa is felt and studding this will be numerous soft, often pedunculated, tumors of varying sizes. When these are numerous and of nearly the same size, as is usually the case, one gets the sensation of passing the gloved finger over the surface of a rubber scrubbing brush.

Observation of the stools or rectal discharges may be very helpful, both from the gross and microscopic standpoints. In polyposis of colitis there may be purulent bloody discharges separate from or mixed with a small amount of fecal material. In adolescent polyposis, there may be loose stools, at times even watery, streaked with blood, but purulent bloody discharges apart from the stools are not noticed, or the stools may vary from fairly well-formed stools to mushy stools with blood streaking. Occasionally one observes a case in which there is a history of loose stools since childhood, but in which the condition did not cause great concern until blood appeared. The appearance of blood may be an indication of enlargement of some of the polyps or malignant change in some of them.

Although one obtains definite diagnostic suggestions from all of these measures, the sigmoidoscope, giving clear vision of rectal and sigmoidal lesions, is an invaluable diagnostic aid, and the roentgenographic and roentgenoscopic examinations are most important and have made distinct advances in the immediate past.

The differential diagnosis of polyposis of the large intestine should include solitary adenomatous polyps, tuberculous colitis, localized inflammatory tumors of the colon, regional or localized chronic ulcerative colitis, and malignant new growths including carcinoma and sarcoma.

Benign, solitary polyps are often difficult to distinguish from malignant neoplasms and should be treated as potential carcinoma.

Tuberculous enterocolitis with its usual preceding pulmonary disease rarely causes difficulty in diagnosis.

The diagnosis of chronic ulcerative colitis, local inflammatory disease such as diverticulitis, and malignant lesions is usually established by the proctoscope or roentgen ray.

Regional or localized chronic ulcerative colitis offers the greatest difficulty. Although chronic ulcerative colitis usually begins in the rectum, it may attack any part or all of the large intestine; in its diagnosis, the roentgen ray is the only reliable diagnostic aid.

SUMMARY

It has been definitely established that colitis is the basis of one form of polyposis. Colitis may bear a relationship to all polyposis of the large intestine but its relation to the adolescent type would be difficult to establish. Inflammatory disease or irritation of some kind may play a part in the formation of disseminated or solitary polyps.

The important differential diagnostic data include a carefully taken anamnesis, general examination, rectal digital examination, observation of the stool and rectal discharges, both grossly and microscopically, sigmoidoscopic investigation, and roentgenology.

The diseases from which polyposis must be distinguished include tuberculosis of the intestine, chronic ulcerative colitis, diverticulitis, and malignant neoplasms.

REFERENCES

1. BROWN, LAWRASON, and SAMPSON, HOMER. Intestinal Tuberculosis, Its Importance, Diagnosis and Treatment; A Study of the Secondary Ulcerative Type. Ed. 2, Philadelphia, Lea and Febiger, 1930, p. 376.

2. ERDMANN, J. F., and MORRIS, J. H. Polyposis of the colon; a survey of the subject. *Surg., Gynec. & Obst.*, 1925, *40*, 460–468.

3. FITZGIBBON, GRATTAN, and RANKIN, F. W. Polyps of the large intestine. *Surg., Gynec. & Obst.*, 1931, *52*, 1136–1150.

4. KENNEDY, R. L. J., and WEBER, H. M. Polyposis of the colon in children. *Am. J. Dis. Child*, 1931, *42*, 69–76.

5. MACCARTY, W. C. Chronic ulcer and carcinoma of the stomach. *Am. J. M. Sc.*, 1927, *173*, 466–472.

6. OSLER, WILLIAM. The Principles and Practice of Medicine. Ed. 11, New York, D. Appleton and Company, 1930, p. 495.

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THE UNDESCENDED CECUM

A STUDY OF ITS EMBRYOLOGY AND VISCERAL LIAISON AS BEARING ON THE ROENTGEN EXAMINATION*

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THE alimentary tract seems to continually engage in intrigue against the sleuthing propensities of the internist and the visual acuity of the roentgenologist. One sometimes would attribute to it a peculiar cunning in methods and means of throwing the student off the trail of the causative difficulty. Points of definite tenderness are more often not at the point of the lesion than in any other portion of that odd machine, the human body. We ourselves ascribe all sorts of troubles, "sins and sorrows" Bland-Sutton puts it, to the alimentary tract and its side chain of contributory glands and pouches. Almost daily there comes the patient who answers one's question of "What is the trouble?" with "I think I have liver trouble, Doctor." And then begins the attempt to find a clue among the varied and vague symptoms which the patient has often acquired from his best friend, neighbor, or bridge-table acquaintance.

Consequently, for the roentgenologist there is no little interest attached to a problem in differentiation of the etiology of those more or less vague abdominal, and particularly epigastric, disturbances. I am speaking now not of the patient who presents a fairly well-defined symptom-complex of gastric ulcer, duodenal ulcer, cholecystitis of relatively acute onset, or appendicitis. But there are those patients who present recurring epigastric distress, no jaundice, no appreciable colic, some relation of their distress to the time of eating (and yet not constant or typical), some food displeasures such as the tart fruits, raw apples, tomatoes, cabbages, and fatter meats, and yet present tenderness both in the right upper quadrant and in the right lower. One is presented then with a problem in functional as well as organic pathology.

Two such patients were recently referred to us for study. (A third case is introduced which came to us later.) The clinical findings provoked the old query of, "Why?". This paper is the story of our attempt to find a solution to the riddle, which is after all but a simple problem in embryology, anatomy, and physiology. We shall present these with a review of similar cases from the available source literature. The major interest has been in the review of the embryology, and an attempt to discover some corroborating evidence in the newborn infants in our hospital.

I. PRESENTATION OF CASES

CASE 1. Mrs. L. L. D., aged thirty-one, housewife. Referred August 6, 1928 (Dr. Glenn Miller).

Complaint. Pain in the upper right abdomen.

Course of Disease. Up to onset of present illness, patient has been healthy. On July 9, 1928, she experienced a constant severe pain in right upper quadrant that did not radiate elsewhere. The pain lasted for a week, and during the time was sufficiently severe to cause her to keep her knees drawn up, and an ice bag over the area of pain. No vomiting. No chills. Was constipated. Temperature to 103° F.

Patient has experienced no previous distress from any kind of food. Could eat anything. Has never been jaundiced, and had no eructation of gas. Is not ordinarily constipated. The patient had had but the one attack and has not had any trouble since.

Past History. Pertussis and mumps in childhood. Tonsillectomy three years ago. Married six years. Two children alive and well, one child died in infancy.

Family History. Negative.

Physical findings reported were abdominal rigidity, localized tenderness under costal

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Fig. 1. Case 1. Barium enema showing subhepatic cecum and appendix, inverted ascendens, incompetent ileocecal valve.

margin, but also over McBurney's point. At the time of roentgen examination the whole affair had completely subsided.

Roentgen Examination—August 6, 1928. A study of the colon by opaque enema (Fig. 1) showed a redundant sigmoid, normal descendens with high splenic flexure, and low-slung, fairly movable transversus of rather gross caliber. There was no hepatic flexure. An appendix of irregular lumen was demonstrated cephalad to the right end of the colon, twisted on itself, and apparently fixed in part to the low liver margin. This was quite tender (Fig. 2).

Conclusion. Non-descent of cecum with probable perityphlitis. Patient has had no recurrence so far as is known. She refused operation.

Case II. Mr. R. C. H., aged forty-four, insurance agent. Referred June 8, 1928 (Dr. C. R. Kennedy).

Complaint. Spasms of abdominal pain following meals. Indigestion.

Course of Present Disease. Up to two and a half years ago the patient was in good health. In November, 1926, following "flu" (severe chills, fever, and general body ache) he had a severe pain radiating through lumbar region necessitating hypodermic for relief. There was some disturbance in function of the right kidney and nephrectomy had been considered. In June, 1927, an attack of indigestion was accompanied by severe pain which was more anterior in location, vomiting, and temperature of 102° F. Cystoscopy three days after this acute attack with ureteral catheterization revealed low grade inflammatory changes in the bladder mucosa, right ureter admitted a No. 5 catheter. Urine contained a few pus cells. Kidney excreted more than 15 per cent phenolsulphonphthalein in thirty minutes. Roentgenogram showed possible calculus in the right pelvis. Between these attacks, and since the last one, he has had much "indigestion" but no urinary complaints. Distress following eating was referred to as "spasms of pain" across his abdomen which felt as though his food were "being held back" in passage. Gastrointestinal examinations by a local roentgen laboratory in February, 1926, and at a well-known clinic in 1927 were reported negative. Symptoms had been growing more severe each day.

Fig. 2. Case 1. Detail of cecum and appendix.

Past and Family History. Typhoid fever in 1915. Influenza in 1918. Married seventeen years—wife and four children alive and well. Mother, father, four brothers, and two sisters living and well.

Roentgen Examination—June 8, 1928. An essentially normal thoracic cage and viscera, considerable aerophagia. Ingestion of the barium acacia mixture was accompanied by gulping of more air. Upon ingestion of the opaque meal a peculiar series of peristaltic and antiperistaltic oscillations took place in the stomach. This was accompanied by some movement of the diaphragm and a slight amount of motion of the abdominal musculature. There was a slight increase in peristalsis and a marked dilatation of the duodenum in the second and third portions, together with active antiperistalsis (Fig. 3). No appreciable tenderness over the duodenum; but slight tenderness to the right and slightly caudad was noted. At six hours the stomach was empty. The head of the barium column was in the cecum. At twenty-four hours there was some barium scattered throughout the large bowel. The appendicial shadow was found lateral and posterior to the shadow of the proximal transverse colon. Introduction of a barium enema (Fig. 4) demonstrated the bowel increased in caliber throughout. The tip of the cecum was fixed under the liver margin and above that the sharply angulated, long, segmented appendix (Fig. 5). This was grossly tender.

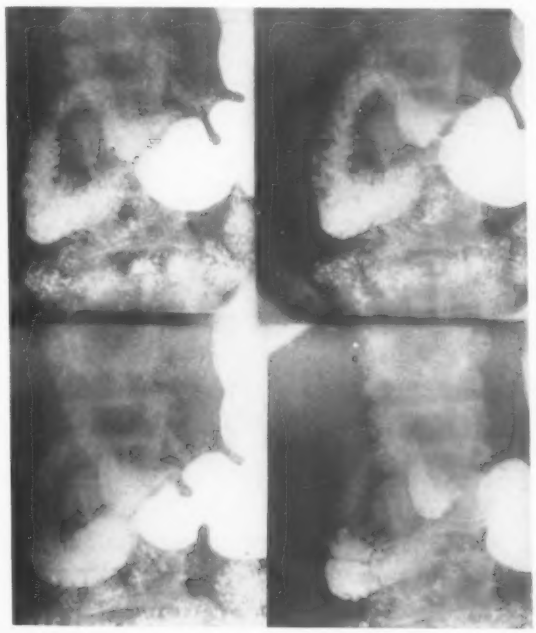

Fig. 3. Case II. Serial roentgenograms of stomach and duodenum, the latter dilated.

Fig. 4. Case II. Barium enema showing subhepatic cecum; appendix kinked along the liver margin.

Our findings, so far, indicated a rather marked reflex irritation of the stomach, aerophagia, a dilated duodenum, and a subhepatic appendix with non-descent of the cecum.

Detailed studies of the gall-bladder area after the ingestion of tetraiodophenolphthalein did not show any shadow which could be interpreted as that of a normal gall-bladder. The films present a very fine view of the inverted cecum and appendix in close approximation to the liver margin (Fig. 6).

Conclusions. Probable dysfunction of the gall-bladder. Non-descent of cecum and appendix. Probable perityphlitis.

Physical examination on admission to hospital June 15, 1928. Tenderness on deep palpation under right costal margin with some sensation of nausea. Palpation over area just medial to anterior-superior spine of right ilium elicited some tenderness. Otherwise physically in fair condition. Blood count June 16, 1928: Hemoglobin, 85 per cent; red blood cells, 4,700,000; white blood cells, 7,600; polymorphonuclears, 70 per cent; small lymphocytes, 30 per cent.

Fig. 5. Case II. Detail of cecum and appendix.

Laparotomy June 16, 1928—Surgeon's note: "Undescended cecum. Appendix about 6 or 7 inches long, acutely kinked, lay just beneath the gall-bladder and adherent to duodenum, held cecum in high position. Appendix was exactly as shown by x-ray. Stomach normal size, a few adhesions near pylorus, suspicious of previous ulcer but no active ulcer at present. Gall-bladder of strawberry type, wall thickened and opaque, few adhesions in lower portion, filled with very thick black bile. No stones."

Appendectomy and cholecystectomy.

Patient had a very uneventful convalescence. Two months after the operation he reported himself free from his previous complaints and pursuing his routine work. Eight months later, he reported as considering himself clinically cured.

Further interest in the consideration of the undescended cecum was stimulated in July, 1929, with the addition of the third case of the series. The history ran briefly as follows:

Case III. Mrs. E. M., aged thirty-five, saleswoman, presented herself complaining of pain under the right shoulder blade, apparently connected with distress in the right hypochondrium. Family history, negative. One daughter, fourteen years old, living and well. Past history, no gross complaints. (Dr. Palmer Findlay.)

Present Illness. Five years ago the patient noticed that she was having considerable distress after eating fried foods, apples, onions, cabbage, and mayonnaise dressing. This distress took the form of discomfort beneath the right rib margin, associated with the belching of considerable gas, and occasional pain beneath the right shoulder blade. Occasional nausea was associated with the difficulty. Her feeling at that time was that her side would burst if she did not receive some relief. During the last two years the pain described underneath the right shoulder blade has become more prominent and somewhat sharper with the addition of headaches and general debility at the time of the attacks.

Physical examination revealed considerable tenderness beneath the right rib margin with especial tenderness in the right lower abdomen, in the area described as McBurney's point; otherwise no gross irregularity. No palpable tumor masses. Blood and urine examination

Fig. 6. Case II. Detail of gall-bladder area, after oral administration of tetraiodophenolphthalein. Note appendix along the liver margin.

essentially negative, save for a slightly low hemoglobin. Temperature on admission to the hospital was 99°, pulse 75, respirations 15.

Roentgen examination of the gall-bladder and gastrointestinal tract was as follows:

Studies of the gall-bladder area following ingestion of the dye demonstrate a very large gall-bladder, uniform in contour, underlying the last rib shadow and apparently in close approximation to the large bowel. After a fat meal the viscus had decreased to about ¾ its original size. At eighteen hours it was still large, and at thirty-six hours the shadow persisted in about 50 per cent the original size.

Roentgenoscopy of the chest revealed some increase in the bronchovascular markings on the right side, the lung fields however being essentially healthy. The barium meal filled out a medium-sized J-type, tonic stomach. The duodenal bulb was large, could be filled with pressure, and showed a persistent pressure defect on its lesser curvature. The second portion of the duodenum was angulated and locally tender. The stomach had emptied at six hours. The head of the barium column had reached the splenic flexure and the small intestine apparently occupied the right flank and right iliac fossa without the cecum appearing, unless it were hidden behind the proximal portion of the large bowel.

Fig. 7. Case III. Detail of appendix and inverted cecum. Patient supine.

Fig. 8. Case III. Barium enema, patient prone. Note inverted cecum with appendix along the duodenum.

Examination at twenty-four hours revealed a trace of barium lying well up along the liver margin with apparently an inverted hepatic flexure. Introduction of a barium enema demonstrated a somewhat smoothed-out sigmoid with high splenic flexure and inversion of the hepatic flexure and fixation of the cecum and appendix under the liver margin in close proximity to the gall-bladder.

The findings during this examination are interpreted as indicating an obstruction to proper emptying of the gall-bladder, non-descent of the cecum, with a probable periappendicitis, and pericholecystitis.

Reproductions of the films made at the time of introduction of the barium enema are given in Figures 7 and 8.

These three patients present, then, upper right quadrant distress, in the first, without food association and one acute attack; in the second, with indefinite food association and a long history of increasingly severe exacerbations, and in the third, with definite food association and an

increasing type of cholecystitic sydrome. But all had tenderness over the right lower quadrant as well. The answer to our query, "Why?", may be found in the growth and development of the canal.

That we may offer later a more comprehensive view of the subject, a review of the available source literature would seem to be in order.

2. REVIEW OF LITERATURE

Identical examples of any disease complex or syndrome are rarely encountered in the human. Further, the frequency of observation of the abdominal content, save at the necropsy table, was low prior to the advent of abdominal surgery.

Walsham in 1880 reported a case of left-sided cecum. Lockwood in 1882 quoted Simpson (*Edinburgh Medical Journal*, 1839) as stating that intrauterine peritoneal inflammation might be the cause for the irregular veils or folds of peritoneum which were later to acquire the names of the several surgeons of the late nineteenth and early twentieth centuries. An article by Turner in the same periodical, but of 1863, is mentioned in which is described the finding of a cecum in the right hypochondrium, the small intestine lying in the fetal position in the right flank, but no evidence of inflammation. He then discusses one patient, a male, aged fifty-seven, in whom at autopsy (the death having resulted from obstruction by malignancy of the lower descending colon), the cecum was found just beneath the liver. This patient further had a double descending colon. This paper also described a cecum opposite the iliac crest (possibly one of the "high ceca" as classified by Kantor) in a male cadaver. This individual further had shown undescended testes. Lockwood raised the question then, quoting Simpson again, Serres, and G. St. Hilaire, of the possibility of a connection between embryonal arrests, in that one of these peritoneal bands passing from the under surface of the mesentery near the ileocecal valve to testis or ovary might affect the descent of one or the other. He further describes such a relation in an eight-month fetus with undescended testes but a cecum opposite the iliac crest, and cites reports of other cases of malposition of the cecum.

Treves (1885) reported 2 cases of subhepatic ceca occurring in a series of 100 cadavers examined. These two cases presented a cecum continued in the axis of the transverse colon with the appendix posterior.

Farenholt (1894) reported one case of cecum in the right hypochondrium, close to the gall-bladder, but with the appendix lying free and caudad. Hartman (quoted by Fowler, 1916), reported a subhepatic cecum in a man aged fifty, the small intestine lying in the right flank. Delbet (1897) reported a case of subhepatic cecum. This one had started on its descent.

Mayo (1912) in a discussion of non-rotation of the colon reported 5 of partial or incomplete rotation, all of which showed a left iliac appendix. One had epigastric distress without local lesions, one right iliac tenderness. Black (1912) cites a case of his own with recurrent right lower quadrant pain but a subhepatic cecum, the sigmoid also lying on the right. He makes a rather particular point of the scarcity of anomalies of the descending colon. Shober is quoted as reporting a case with right lower quadrant pain but no sign of cecum or appendix on operation, the sigmoid lying in the right iliac fossa. Fowler (1916) reporting 3 cases, one with periumbilical cramping pain, a high cecum, and retrocecal purulent appendix in that position, one with tenderness over McBurney's point and under the right rib margin with a subhepatic cecum and appendix, and one with rigidity in the right lower quadrant, but a cecum and appendix beneath the umbilicus, and reviews the cases of Treves, Farenholt, Hartman, Delbet, and Lockwood (loc. cit.) Further he quotes Robinson as finding 2 undescended ceca in 130 autopsies, and a case of Borders' in which a gangrenous appendix, retroperitoneal, and lying on the right kidney was found behind a very

short cecum in the subhepatic position. There was no ascending colon. We shall attempt later to show why Eastman (1916) should say in this relation that retrocolic and retroperitoneal appendices are due to a fixation of the appendix during the period of descent and fusion of the approximating folds of the mesentery and mesocolon.

In this connection, considerable interest is shown by Harvey (1918) in his rather extensive bibliography, but especially the reference to Meckel's publications on the embryology of the tract in 1817, and John Hunter's observations in 1802 on the relationship of the canal to the celom. He quotes Riedel as commenting that adhesions might possibly offer a syndrome simulating a chronic appendix.

Carter (1920) in a study of the roentgen findings in 1,284 cases, reported 301 of abnormal placement of the colon. These are further classified as follows:

	Per cent
Abnormal placement not associated with other lesion	8
Symptoms referable to abnormality	20
Cases of ileocecal pathology with demonstrable gall-bladder pathology	15
These composed 66 per cent of all gall-bladder infections in the series.	
Cases of ileocecal pathology with demonstrable peptic ulcer	8
This group composed 70 per cent of all peptic ulcers in series.	

We may refer to this group later in relation to the anatomy and rôle of perityphlitis in symptom production.

Roberts (1920) observed that the abnormal placement of the colon was more commonly low in the pelvis than high under the liver.

Gardner (1920) reported an appendix which lay beneath the liver with its tip near the neck of the gall-bladder in a young male negro, who had had repeated right upper quadrant attacks.

Jonas (1921) reported 11 cases of abnormal placement of the cecum in his practice, 3 in the gall-bladder area with cholecystitis, 2 in the midline just below the stomach, one at the umbilicus, and one in the left side. Two of the series are reported in detail as of 1888, both with cecum and appendix in the right upper quadrant. In this paper we find the first reference of the series to the innervation of the gall-bladder and the portions of the colon with a comment on the interrelation of the right iliac hyperalgesia and pericecal involvement regardless of the site of the cecum.

McConnell and Hardman (1923) presented the second appreciably large group of roentgen studies of the colon. Attention is directed to the advantage which the roentgenoscopist has over the anatomist or surgeon in the observation of the posture of the colon. They utilize the same type of wash drawing reproductions of the roentgenogram as Larimore. Their following statement is interesting:

> About the time of birth the cecum is situated in front of the right kidney, near the gall bladder, and the proximal part of the colon possesses a complete mesentery. Then both the cecum and ascending colon gradually descend toward the right iliac fossa.

Held (1924) directs our attention to the blood and lymph drainage of the area. The blood from the cecum and appendix passes via the ileocolic vein to the mesenteric, thence through the portal system, offering an opportunity for hepatic metastasis of infection of cecal origin. The lymph, further, may drain either via the mesentery to the mesenteric glands, or by the peritoneal route to the upper surface of the liver—hence an opportunity for the formation of subphrenic abscess. There is apparently no drainage to the pelvic structures. In passing, one is intrigued by his quotation from Sahli, "The appendix may be considered as the abdominal tonsil, and if diseased, is productive of great evil."

MacLean (1925) considers the right iliac fossa as the normal situation for the cecum in the sixth to eighth month of fetal life. Three cases are reported, two proved by operation—both of these showing ceca similar to our Case 11. Jordan is quoted as saying that mechanical appendicial stasis in such patients is unlikely because of the

dependent drainage. Smith's observations (q.v.) of cecal posture in 1,050 autopsies are discussed.

Orndoff in 1926 made a plea for the complete roentgen examination of the entire alimentary tract. Keaton (1926) reported a case of left upper quadrant cecum with reduplication of the transverse colon. O'Hara (1926) describes a patient presenting a vague abdominal complaint in whom a subhepatic cecum with inverted colon ascendens was found. Whitlock (1926) seems to feel that the placement of the cecum in the right iliac fossa is not common until the fourth month of extrauterine life.

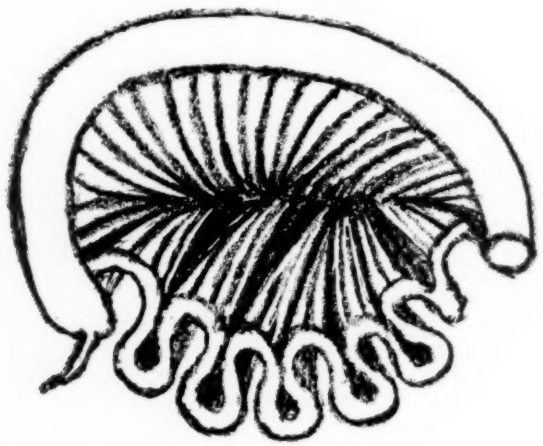

FIG. 9. Treves' diagram of the relation of mesentery and bowel.

Hecker and his associates (1926) elaborate a detailed schedule of classification for "dystopia of the colon."—His third degree of "sinistro-colia" in which the cecum has rotated approximately 270° and lies beneath the liver, with the small intestine posterior to the transverse colon, the duodenojejunal junction lying to the left and below the origin of the superior mesenteric artery would probably resemble our cases.

Fried (1928) has presented 3 cases of a peculiar arrangement which is rather difficult to conceive: a cecum sufficiently free and with adequate mesenteric length to permit it to lie in the subhepatic fossa and yet with ease invert itself into the right iliac fossa on change of the patient's posture to the erect. This is perhaps possible—but certainly uncommon.

Carman (1920) devoted a small section of his excellent book to such abnormalities.

3. PREVIOUS EXPERIMENTAL STUDIES

Treves in 1885 based certain deductions on 100 cadavers examined. In these, as we have noted above, he found two with undescended ceca. His diagram of the mesentery and its relation to the bowel is interesting (Fig. 9). We shall not discuss his ideas of the cause for variation in growth between the large and small intestine.

Smith in 1911 presented a statistical review of the variations in the position of the cecum and appendix covering 1,050 autopsies, mostly of infants less than three months of age. A summary of his findings shows:

	Male	Female	Total
Cecum on left side without rotation	2	3	5
Cecum undescended, subhepatic	31	32	63
Cecum in right iliac fossa	443	439	882
Cecum in true pelvis	34	66	100

The incidence of undescended ceca was 6 per cent in this series. He quotes Hertwig as believing that descent has usually been accomplished by the eighth fetal month.

Davis (1916), on the other hand, found but 1.4 per cent incomplete descent in 285 formalin-fixed adult cadavers:

	Per cent
Normal	32.5
Persisting embryological forms	9.9
Incomplete rotation	0.9
Incomplete descent	1.4
Cecum between umbilicus and pubes	15.5

Further, he believes that the cecum remains beneath the liver until the fourth month post natum.

Payne and Trahar (1921) call attention to the abnormalities which may follow an interruption in the development of the alimentary canal, presenting a discussion of that process.

Treves had thought that all children start with practically the same length of intes-

tine. Bryant (1924), on the other hand, found in a study of the intestine of 45 fetuses and 37 children a variation of 100 per cent.

Larimore (1927) in the wash drawing reproductions of roentgenograms of enemas on 102 infants, ranging from one to thirty days old, and 560 adults, does not show any with unmistakable undescended ceca. The major number of the infants show a long vertical sigmoid.

Kantor (1928), in the most recent of his splendid series of studies on the colon, included all ceca lying above the crest of the ilium in the class of "high ceca." These he finds comprise 5.1 per cent of all colons in his series (54 in 1,049). Of the 54 he found only 3 actually undescended. This would be but 0.2 per cent. He observes, however, that in this group of 54 there is often distress simulating that of chronic cholecystitis together with tenderness in the right iliac fossa.

Kerley and LeWald (1923) describe nonrotation of the colon, but so far as we can discover do not discuss the embryology or other abnormalities due to arrests in process.

One then comes to the end of the review without the establishment of a preponderance of opinion as to the frequency of such an arrest.

On the other hand, it is evident that these present a definite clinical problem—in general, a patient with more or less indefinite gastrointestinal complaint, discomfort referable to both right upper and lower quadrants, resembling in its course either a cholecystitis or perityphilitis, or both; occasionally suggesting a duodenal ulcer.

Further, there is an evident conflict in opinion as to the time at which descent of the cecum normally occurs.

The commonly accepted works on anatomy affirm (as we have shown some clinical observers believe) that the descent of the cecum commonly does not begin until after birth, being delayed even so late as the fourth month of infancy. Discussion with surgeons elicits the dictum generally taught among them that in infancy or childhood in appendicial surgery a relatively high incision is preferable, although it is well known that the infant liver margin is relatively much lower than the adult. But further, the surgeon, who cares for infants to any extent, says that he has rarely seen in the youngest infant (such as those with pyloric stenosis) a cecum in the subhepatic position.

Before presenting the embryology and anatomy of the area, I wish to call attention to an editorial (also quoted by Bryant) in the *British Medical Journal* of 1885, Vol. 1, p. 495:

> The lectures on "The Anatomy of the Intestinal Canal and Peritoneum in Man," delivered last week by Mr. Treves at the Royal College of Surgeons, demonstrate the absurdity of a prevalent idea that human anatomy is a worked-out science. This notion is not only an error, but an evil, like all other fallacies connected with scientific questions.
>
> The brilliant results of microscopical research have decidedly seduced many scientific anatomists from their old enthusiasm for naked-eye dissection. The experience of Mr. Treves has shown that much remains to be done, and always will remain to be done in the dissecting room, without the aid of any lens, excepting those which are necessary, in the form of a pair of spectacles, should the dissector suffer from a disorder of accommodation.
>
> It cannot be doubted, however, that the great evil involved in the belief that the end of human anatomy has been reached, is an excessive confidence in text-books on the subject. It should never be forgotten that a text-book is essentially transitory in character, being a summary of knowledge brought down to the date of its publication, and prepared in a form suitable for instruction. Yet the assertions of text-books are too often held to be sacred traditions.
>
> The account of the cecum as given in works of anatomy would appear to be very ancient. It can be traced back, by the lecturer, from book to book, through many literary generations; and throughout its long history it seems to have undergone little or no alteration. It is one of those descriptions, we are reminded, that form a real anatomical property, and that descend from one author to another with a precision of detail. A more fertile source of error

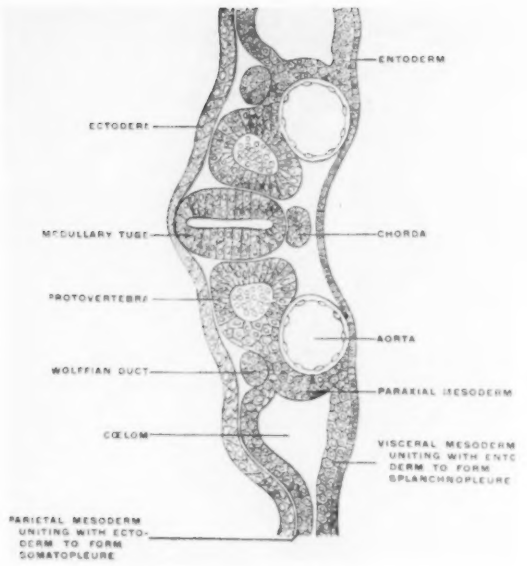

Fig. 10. Embryo of bird, at beginning of third day, with four blastodermic layers, resulting from the division of the mesoderm into parietal and visceral layers, separated by the celom cavity. Transverse section. ×170. (Kollmann.) (Huntington.)

could hardly be conceived; yet we are all aware that similar traditions concerning every part of the human body are handed down from text-book to text-book, while their incorrectness is overlooked by thousands of good observers and patient dissectors. All of us are apt to forget that, in science, nothing written must be taken for granted.

One is tempted to change the last sentence to this: "All of us are apt to forget that, in science, nothing must be taken for granted."

4. The Growth and Development of the Alimentary Canal

The story of the origin and development of the alimentary canal as told by the anatomists such as Mall, Piersol, and Huntington reads almost like a fairy tale.

(A) Formation:

Very early after the beginning of cell division in the fertilized ovum there is a separation of the blastoderm into the three major cell layers, ectoderm, mesoderm, and entoderm. The entoderm is to become the integument of the embryo, and in the dorsal axial line will develop the median or medullary groove which will afford the cerebrospinal axis. The entoderm will become the lining of the alimentary canal and its appendages, and the mesoderm the skeletal or somatic structure and framework of the body. The latter layer then separates into the parietal mesoderm, or somatopleure, and the visceral, or splanchnopleure, with the primitive pleuro-peritoneal cavity or celom between. The splanchnopleural folds with the entoderm invaginate the yolk, remaining connected with the somatopleure and axial ectoderm in the dorsal midline (Fig. 10). Proceeding ventralward, the germinating layers approach from each side and thus enclose one another, producing the formed embryo connected to the yolk by the stalk or physiological umbilical hernia through which the inner tube—now the primitive enteric, or alimentary canal—is to remain connected by the precursor of Meckel's diverticulum, the vitello-intestinal duct (Fig. 12).

This primitive gut is a nearly straight cylindrical tube with a blind pouch at its cephalic end, toward which the ectodermal bud will proceed to form the anlage of the mouth, the stomodeum, and at the caudal end connects for a time with the medullary tube, the neuro-enteric canal. At this end will in time open the other ectodermal bud (proctodeum) to form the anus—but in the interim the end gut will receive as well the genitourinary ducts forming with it the cloaca. Such a condition persists in the lower vertebrates. In the human, ingrowth of mesoderm assists in the formation of the cloacal membrane followed by the perineal folds which accomplish in time the complete separation of the urogenital structures into the ventral position of the fetus.

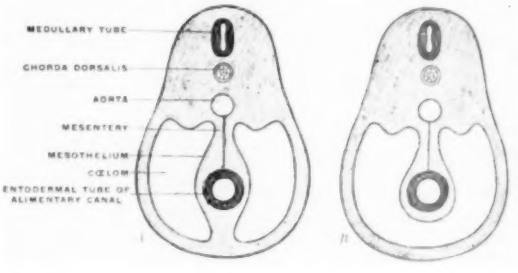

Fig. 11. Schematic diagrams, illustrating the vertebral mesentery. A, earlier, B, later condition. (Minot.) (Huntington.)

(B) Differentiation of segments:

1. Stomach.

Usually by the fifth day, the embryo shows a spindle-shaped dilatation of the primitive tube dorsal to the out-pocketing of the embryonal liver. This spindle increases more on the dorsal margin, which assumes more of the character of the adult greater curvature, the ventral becoming more concave (Fig. 12). This enlargement, forming the stomach, really marks the distal end of the foregut, cephalad to the origin of the liver and hepatic duct from an evagination of the entodermal tube. At the same time the cerebrospinal structures have been developing and this placement of the stomach explains the innervation by the vagus after differentiation.

2. Intestine.

The remainder of the enteric tube elongates more rapidly to form a single U-shaped loop (Fig. 12) beginning just distal to the pylorus and suspended in the celom by the mesentery (Fig. 11). At the tip of the arch of the U-tube occurs the vitello-intestinal duct connecting with the yolk-sac through the umbilical stalk (Fig. 13).

(C) Emigration:

Either because of lack of space in the celom with the oversized liver (Mall) with the rapid increase in length of the gut, or because of traction of the yolk-sac, the U-loop emigrates into the umbilical stalk (the physiological umbilical hernia). A differentiation (at about the sixth week) of the small from the large intestine now

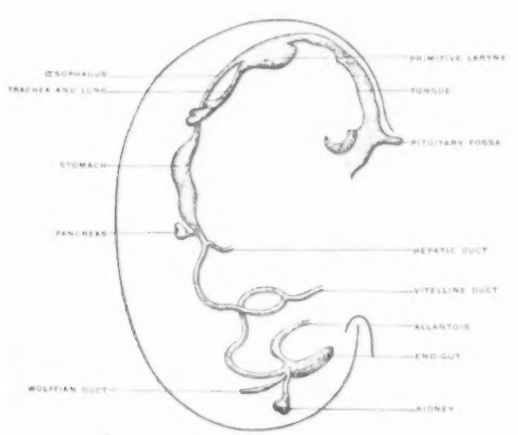

Fig. 12. Reconstruction of alimentary canal of human embryo of 7 mm. (twenty-eight days). ×12. (After His.) (Huntington.)

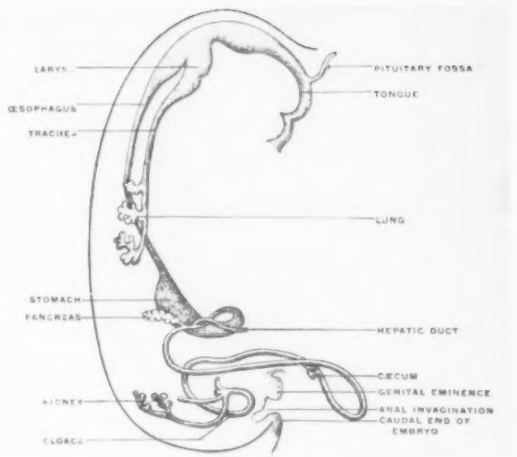

Fig. 13. Reconstruction of alimentary canal of human embryo of thirty-five days (13.8 mm.) ×8. (After His.) (Huntington.)

appears near the arch on the returning or distal arm in the form of a bud, which is to be the cecum and appendix (Figs. 13 and 14, A).

At about the same time (sixth week), the duodenum forms a short loop or bend between the pylorus and the hepatic duct (Fig. 13). The entire canal remains attached by the mesentery to the dorsal median line of the abdominal cavity just ventral to the aorta and vertebral column. The blood supply has been established (Fig. 14, A).

By the seventh week the proximal loop begins to grow rapidly and forms the coils which are to become the mature jejuno-ileum. The mesentery as a result shows considerable folding or pleating. There is then formed a sort of isthmus at the origin of this portion of the mesentery, namely between the duodenum and that part of the distal arm of the early U-tube which is to form the splenic flexure and descendens of the matured fetus (Fig. 14). Between these relatively fixed portions the mesentery spreads as a fan from its handle transporting the superior mesenteric artery and the proximal branches of the inferior.

(D) Immigration.

The continued growth of the proximal loop, with its multiple lesser loops, and the elongation of the fetus (about 40 mm.) now permits the return of the intestine to the celom. The upper or proximal loop—now the early jejuno-ileum—has lain toward the right, the distal toward the left. The stomach has rotated be-

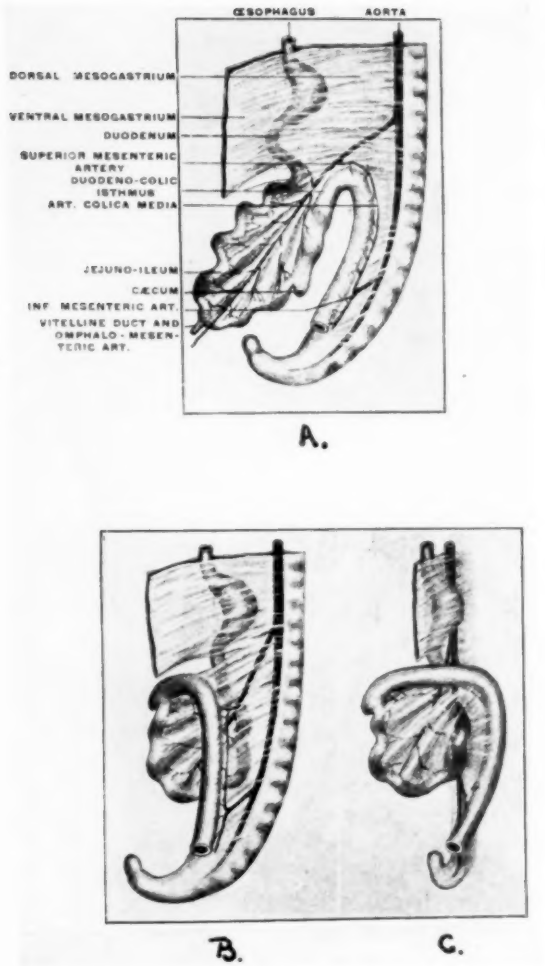

Fig. 14. A. Schematic representation of alimentary canal with umbilical loop and mesenteric attachments in human embryo of about six weeks. B and C. Stages in the intestinal rotation. (Huntington.)

neath the liver so that its original right side presents dorsad—its left ventrad. As a result the coils of the small intestine return to the right celom. This is a progressive migration from above downward or cephalo-caudad, so that the distal loop, largely the early proximal colon, returns last, and to the left hypochondrium, the lesser intestine filling the whole right flank. Such is the arrangement in about the third month (Fig. 14, B). The cecum and proximal colon are then displaced still further toward the upper left flank by the continued relatively rapid growth of the jejuno-ileum in the right.

(E) Rotation:

Apparently for want of other space, and more or less in the circumference of the mesenteric circle with its axis at the duodeno-colic isthmus, the growing colon rotates to the right along the caudal surfaces of the stomach and liver, ventrad to the duodenum. When it arrives in the neighborhood of the right kidney, the jejuno-ileum perforce lies caudad to and to the left of the cecum. The ileocecal junction however has remained on the cephalad aspect and toward the right. Of necessity now it will in the same process rotate posteriorly about the longitudinal axis of the transversely situated cecum to present caudad and on the left (Figs. 14 to 17).

Thus ends the period of rotation.

(F) Descent and fixation:

Evidence and opinion now vary markedly, for this position is that described by the text-books for the cecum at birth. Piersol advances the belief that during the fourth month of extrauterine life the sigmoid—which had been the longest section of the colon—becomes relatively shorter and other parts proportionately longer, resulting in a pushing of the cecum down into the right iliac fossa with a lengthening of the ascending colon. Such may be true, but it is hard to conceive of the loop of large intestine slipping through the mesentery from below upward as one slips his arm through a shirt-sleeve.

One can more readily conceive of further growth in the proximal large bowel, which, as a

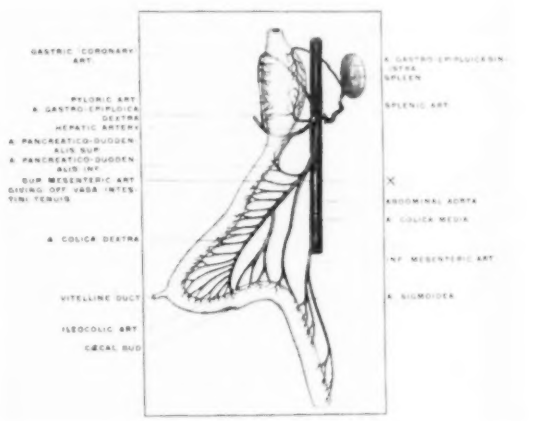

Fig. 15. Diagrammatic representation of the arteries proceeding to the alimentary canal and appendages prior to rotation of intestine (stage of simple umbilical loop). (Huntington.)

result of the fixation of the descendens before, or simultaneously with, the migration period, would more easily be accomplished in the freer transverse segment. But this is hampered somewhat by its mesenteric attachment and made to conform to the radius of curvature of that structure, and there is possibly a mechanical factor of the opening of the ileum into the colon to tend to turn that hiatus medially downward. Hence the next step in the process would normally be a coursing downward in the right flank.

Such is our concept of the period of descent which probably occurs between the sixth and eighth fetal month.

Fixation may occur at any stage after the return of the intestine to the celom. It is the establishment of the permanent posture of the alimentary tube by the adhesion of one or both mesenteric surfaces to the parietal mesothelium or peritoneum, and hence partial or complete burying of the segment retroperitoneally (Fig. 19). Our usual expectation in fixation would be the obliteration of the ascending mesocolon. Lack of such fixation would give rise to the condition known as "cecum mobile." The premature fixation of the appendix or cecum in the process of descent might result in the retroperitoneal, or retrocecal appendix as discussed by Eastman (loc. cit.). The relative size and position of the fetal liver will undoubtedly influence the differentiation of the hepatic flexure from the ascending colon—

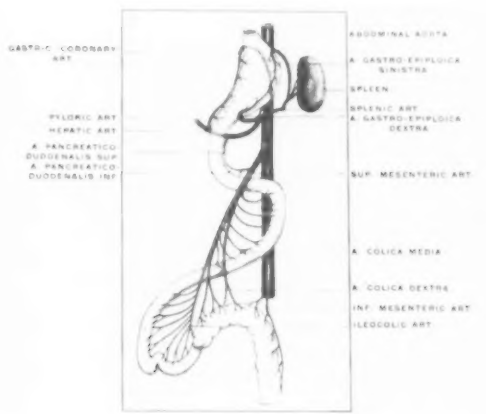

Fig. 16. Diagrammatic representation of the arteries of the alimentary canal in the first stage of intestinal rotation, showing relation of superior mesenteric artery to the transverse portion of the duodenum. (Huntington.)

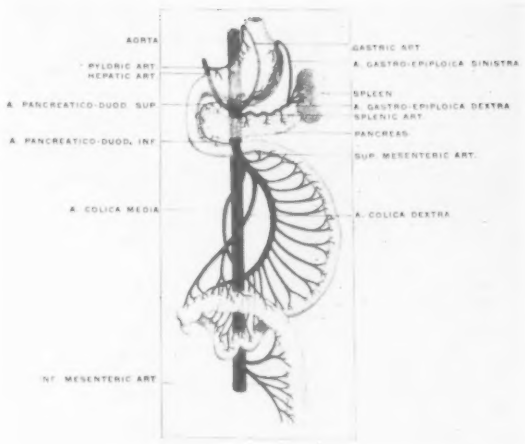

Fig. 17. Arteries of alimentary canal in the later stages of intestinal rotation. (Huntington.)

affected also by the traction of the mesocolon on the latter.

(G) Blood supply:

The abdominal aorta is probably the result of the fusion, or obliteration of part, of the bilateral primitive aortae as shown in Figure 10, of which the common iliac vessels are remnants. The bilateral allantoic vessels become the umbilical and might be considered as end branches of the aortae. Later when they atrophy and are obliterated the iliacs replace them as end branches.

The arteries of the yolk sac are the multiple omphalomesenteric. As the primitive gut moves away from the vertebrae with the development of the common mesentery, the omphalomesenteric vessels possibly unite to form single vessels lying between the layers of the mesentery. Thence they proceed to divide again to surround the enteric tube and anastomose on the ventral side. With the cessation of the vitelline circulation the distal sections disappear. The proximal remain as the superior mesenteric artery and its branches.

The stomach and duodenum and associated organs are supplied from these precursors of the celiac axis. The superior mesenteric anlage passes to the small intestine and proximal colon through the mesenteric isthmus. As rotation proceeds this vessel will lie ventrad to the transverse portion of the duodenum with the exception of the a. pancreatica-duodenal inferior.

The caudal intestinal artery from the aorta now forms the inferior mesenteric to the distal colon (Figs. 15 to 18).

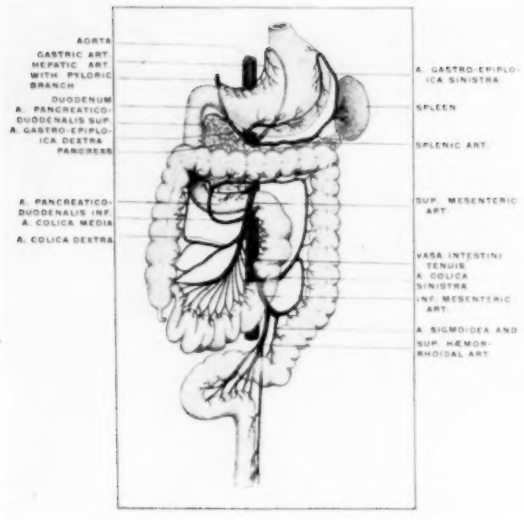

Fig. 18. Final arrangement of arteries of alimentary canal after completed rotation of the intestines. (Huntington.)

(H) Venous and lymph drainage:

The blood and lymph drainage has been described above under Held (Sec. 2.).

(I) Mesentery:

This mesenteric development has been described with that of the enteric tube. Following rotation, the transverse mesocolon divides the abdominal space into the upper and lower segments—and by approximation of the peritoneal coating of the stomach will produce the lesser and greater sacs respectively.

(J) Nerve supply:

Allusion has been made above to the connection of the vagus in the circuit. The distribution of the sympathetic or autonomic channels may be considered as chiefly via the celiac plexus.

In Figure 20 there is shown diagrammatically the relation of the tracts of the afferent and efferent channels of the autonomic system. One must keep in mind the fact that the afferent tracts from the stomach, liver, pancreas, intestine and kidney, as well as the colon, pass through the celiac ganglion or superior mesenteric in close association to the lower thoracic and upper lumbar cord segments. Hence there is afforded a ready-made transmission and reference agency for stimuli from one to the other—and especially to the somatic system of the external musculature and sensory centers. We may understand then possibly, the connection between the points of tenderness of an appendicial inflammation by a reference mechanism, although the localized point on deep palpation might be, in the case of an undescended cecum and appendix, under the costal margin and hence confusable with the gall-bladder. Further, we may also appreciate the cause for the hyperirritability of the stomach, duodenum and gall-bladder in the case of appendicial inflammation. And this prevails regardless of the position of the cecum and its appendage. That is, the neural connections are not influenced by an incomplete life history. They have been formulated long before.

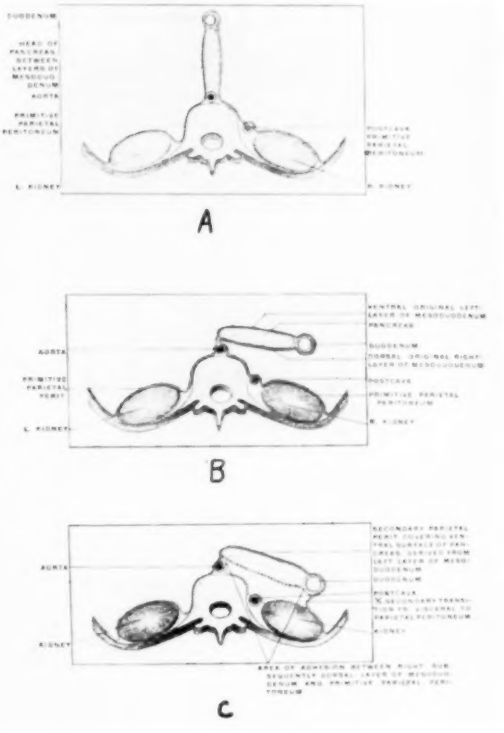

Fig. 19. Diagrammatic representation of three stages in the development of the mesoduodenum, duodenum, and pancreas leading to the secondary "retroperitoneal" position of these viscera. (Huntington.) A. Free mesoduodenum in sagittal plane, including head of pancreas between right and left layers. B. Mesoduodenum folded to right; left leaf has become ventral; right dorsal, directed toward primitive prerenal parietal peritoneum. C. Fixation of head of pancreas and duodenum under cover of secondary parietal peritoneum by adhesion of opposed surfaces of mesoduodenum and primitive parietal peritoneum.

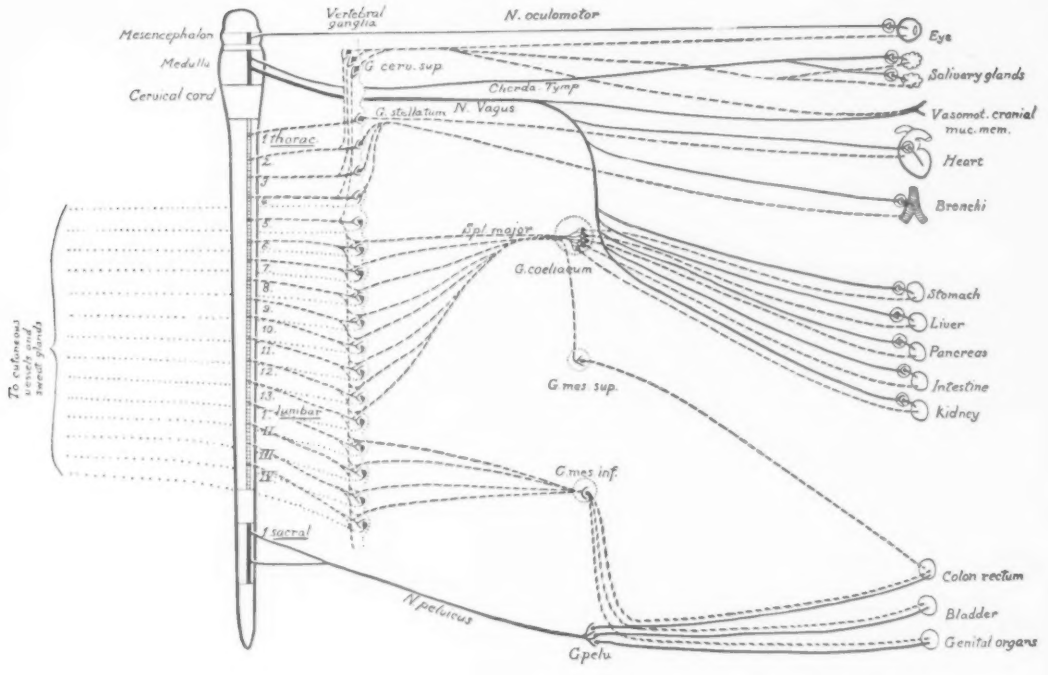

Fig. 20. Diagram of the autonomic nervous system: Solid black, the craniosacral subdivision of the autonomic system; dash and stipple, the thoracicolumbar subdivision. (Modified from Meyer and Gottlieb.) (Ranson.)

If then, one would assume that the development of the enteric canal had been arrested at the end of rotation (Fig. 21, d-f) and fixation occurred at that point, we would duplicate in large measure the condition found in our three cited cases. Further, we can also appreciate the mode of travel of neural stimuli from the cecum, although in that position, to the somatic system with a resultant spasm in the lower anterior abdominal muscles offering resistance and tenderness on palpation due to the muscle spasm, and a referred sense of pain as well.

Our curiosity, however, has been aroused as to the frequency of occurrence of such an arrest—and, more particularly, in the position of the cecum in the new-born. This is enhanced by the apparent variation in opinion among the several observers cited.

5. Experimental Study of the New-born and Infant Colon

We obtained the consent of the Department of Pediatrics to study the colon of the new-born by barium enema. Those who have ever given enemas to infants will appreciate the difficulties which we encountered in a squirming, non-cooperating infant. This, together with our natural caution as to the possibility of upsetting the infant gradient, has limited our series to a group of 23, comprising:

Age	Male	Female	Total
1 day	4	4	8
2 days	3	2	5
4 days	1		1
5 days	2		2
10 days	1		1
3 months		1	1
4 months		1	1
7 months	1		1
2 years	1		1
3½ years	1		1
8 years	1		1
	15	8	23

These may be tabulated as follows:

Name	Sex	Type of Small Intestine	Sigmoid	Colon Filling	Position of Cecum	Hepatic Flexure	Appendix
One day old							
Weinberg	M	Right	Vertical	Good	Above crest	+*	–
Lindsay	F	Adult	Vertical	Half gas.	Iliac crest	+	–
Reese	F	Adult	Rt. iliac	Good	Below crest	+	–
Smith	F	Fetal	Rt. iliac	Fair	Above crest	+	–
French	M	Adult	Adult	Fair	Liver edge	+	+
Anderson	M	Adult	Rt. iliac	Fair	Above crest	+	–
Grimes	M	Fetal	Vertical	Poor	?	+	–
Rosek	F	Adult	Rt. iliac	Poor	Descending	+	–
Two days							
Evans	M	Fetal	Fair	Fair	Midway above crest	+	–
Munhall	M	Adult	Vertical	Poor	?	+	–
Taylor	F	Adult	Rt. iliac	Good	Begin. desc.	+	–
Mordust	F	Fetal	Rt. iliac	Good	Pelvic	+	–
Evans	M	Adult	Vertical	Fair	Iliac fossa	+	–
Four and five days							
Beasley	M	Adult	Vertical	Good *Gross redundancy*	Iliac crest	+	+
Hasselock	M	Fetal	Vertical	Good	Iliac crest	+	–
Veshey	M	Adult	Vertical	Good	Iliac fossa	+	–
Ten days							
Williams	M	Adult	Vertical	Partial	Iliac fossa	+	–
Two months							
Hamaker	F	Adult	Adult	Good	Iliac crest	+	–
Seven months							
Dusek	M	Adult	Vertical	Fair	Above crest	+	–
Two years							
Bates	M	Adult	Adult	Good	Iliac fossa	+	–
3½ years							
Tegop	M	Adult	Adult	Good	Above crest	Redundant	+
8 years							
Mullis	M	Adult	Adult	Good	Iliac crest	+	–

* The hepatic flexure is noted as positive (+) if definite angulation and descent of proximal gut is evident; the appendix positive (+) if filled by the enema.

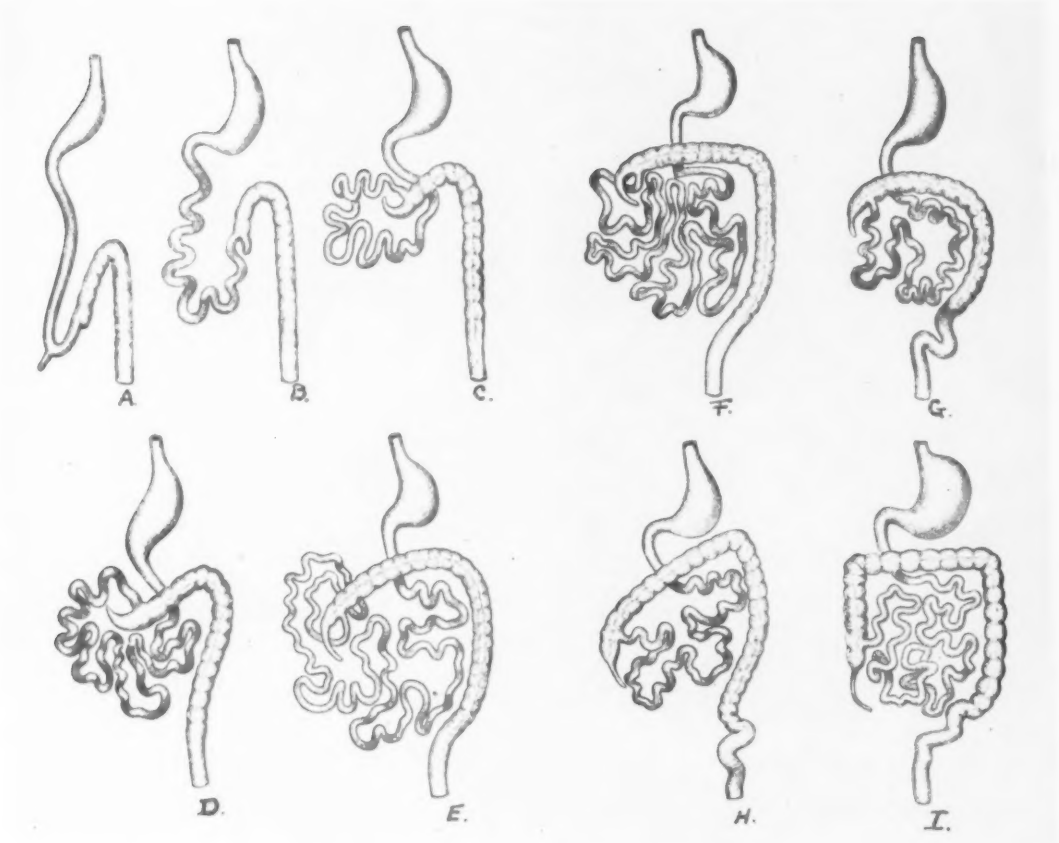

Fig. 21. Series of schematic figures illustrating stages in the rotation of the intestinal canal. (Huntington.)

We have had of course to study the films in the light of our roentgenoscopic observations of each injection and, in some, complete the barium shadow with the delineation of the gas column, usually in the ascending colon. In the 17 aged ten days or younger no positive undescended cecum was found.

A tabulated analysis runs as follows:

	1 day	2 days	4 and 5 days	10 days	Older	Total
Small intestine in right flank (fetal)	3	2	1	0	0	6
Small intestine of adult type	5	3	2	1	5	16
Colon fairly well filled	5	4	3	0	6	18
Sigmoid—vertical	3	2	3	1	1	10
Sigmoid—right iliac "S."	4	2	0	0	1	7
Sigmoid—adult type	1	1	0	0	4	6
Cecum—undescended	?1	0	0	0	0	1?
—poorly defined	1	1	0	0	0	2
—above iliac crest	3	2	0	0	2	7
—at or below crest	3	2	3	1	4	13
Positive hepatic flexure	7	5	3	1	6	22
Appendix visualized	1	0	1	0	1	3

Reproductions of four of the roentgenograms are found in Figures 22 to 25.

Fig. 22. Reese, female, one day, cecum below crest; hepatic flexure + and sigmoid, right flank, s-shape; colon redundant (retouched).

Fig. 24. Beasley, male, five days; small intestine adult; cecum iliac crest; hepatic flexure +; sigmoid vertical; gross redundancy of colon (retouched).

Fig. 23. French, male, one day, cecum descending; appendix fetal; hepatic flexure ±; sigmoid adult (retouched).

Fig. 25. Tegop, male, three and a half years; cecum above iliac crest; appendix visualized; hepatic flexure +; sigmoid adult (retouched).

6. THE COLON OF THE CADAVER

As an item of further interest in the consideration of the prevalence of interruptions in the growth process of the colon, and particularly the cecum, the 23 *male* cadavers utilized in 1929 by the class in gross anatomy were reviewed, with particular reference to the consideration of the placement of the several component parts of the large bowel. This review has been tabulated as in the case of the new-borns in Section 5 above.

	Approximate Age	Small Intestine	Cecum	Appendix	Hepatic Flexure	Colon Transversus	Splenic Flexure	Sigmoid	Colon Ascendens
1.	65	Normal	True pelvic rim	Free retrocecal	Positive	Iliac crest	Normal	Adult	Retroperitoneal
2	45	Normal	Iliac crest	Retrocecal	Positive	Normal	Normal	Vertical Right of Midline	
3	29	Normal	Anterior superior spine	Right iliac fossa	Positive	Normal	Normal	Normal	
4.	30	Normal	Normal	Pelvic	Reduplication	Normal	—	Normal	
5.	40	Normal	Iliac crest	Promontory of sacrum	Positive	Normal	—	Right iliac crest	
6.	60	Right flank	Normal		Positive	Normal	Normal	Above iliac crest	
7.	26		Reduplication of descendens	Long-kinked junction behind ileo cecal junction		Normal	High	Normal	
8.	60		Anterior superior spine	Retrocecal	Positive	U-shape	Normal	Normal	
9.	50	Normal	Brim of true pelvis	Post-iliac	Positive	Normal	Normal	Normal	Cecum and lower half of ascendens free
10.	67		Brim of true pelvis	Pelvic	Free positive	U-shape	Normal	Normal; reduplication of descendosigmoidal junction	
11	35	Normal	Iliac crest	Retrocecal	—	Liver margin	Almost entirely free	Normal	
12.	60	Normal	Right iliac fossa	Pelvic	Positive	Gross	Normal	Right iliac	Attached to right flank
13.	40	Normal	Brim of pelvis	Normal	Normal	Normal	Normal	Normal	Retroperitoneal
14.	58		Midline hyperrotated	Retrocecal		Normal	Normal	Reduplication pelvic	Ascendens and cecum free. Reduplication of distal third with hepatic flexure
15.	50		Crest of ilium	Brim of pelvis fetal	Positive	Normal high	Normal	Normal; reduplication of descendosigmoidal junction	
16.	81	Normal	Anterior superior spine	Pelvic	Positive			Normal	Retroperitoneal

	Approximate Age	Small Intestine	Cecum	Appendix	Hepatic Flexure	Colon Transversus	Splenic Flexure	Sigmoid	Colon Ascendens
17.	39	Normal	Crest of ilium	Normal	Positive	Normal	Normal high	Normal	
18.	63	Partially overlaid by lower ascendens	Iliac fossa; ileo cecal junction; posterior rim of pelvis		Positive	Fixed	Normal	Normal; reduplication of descendosigmoidal junction	
19.	48		Rim of pelvis	8 inches retrocecal				Vertical midline	
20.	46	Normal	Anterior superior spine	Retroperitoneal	Positive		Normal	Normal	
21.	60	Normal	Brim of pelvis	Normal	Normal	Normal	Normal	Normal	
22.	63		Crest of ilium	½ inch retroperitoneal	Normal	Normal	Normal	Normal	
23.	45		Above iliac crest	Normal	Positive	Normal	Normal	Normal	Short

The summary shows that of the 23 there were:

Small Intestine
- Lying in right flank 2
- Adult type 21

Cecum
- Undescended 0
- Above iliac crest 1
- At or below iliac crest 22

Hepatic flexure well defined 18

Appendix
- Midline 1
- Retrocecal 6
- Retroperitoneal 2
- Fetal 1

Sigmoid
- Vertical 2
- Right iliac 2
- Adult type 19

The average age of the cadavers was 54.4 years, the youngest being twenty-six, the oldest eighty-one. In this group there were 2 with rather odd colons. Number 2 had an elongated, entirely vertical sigmoid with a long mesosigmoid. This is demonstrated in Figure 26. Number 12 had a grossly dilated transverse colon with a relatively small vertical type of sigmoid (Fig. 27).

This group of cadavers is of interest in that they were all fixed with the preservative while in the supine position. None of them had had abdominal operations. They may, in a measure, be considered as a relatively representative, although small, group of average male adults.

The assistance of my former interne, Dr. Kazuo Miyamoto, our staff photographer, Mr. Frank H. Shoemaker, and the Departmental staff at the College in the preparation of this paper is deeply appreciated. The permission of Lea and Febiger (successors to Lea Brothers) for the use of illustrations from Huntington and of W. B. Saunders Co. from Ranson is gratefully acknowledged. The facilities afforded us by Professor Poynter in the Department of Anatomy have added much to the value and interest of the study.

7. RÉSUMÉ

(a) Three cases of undescended ceca with clinical histories and roentgen findings are presented.

(b) The literature available is reviewed. Considerable difference of opinion is found among clinical observers and statistical reports relative to the position of the cecum of the new-born.

(c) A review of the embryology and the anatomy of the alimentary canal together with a study of 23 infant and children's colons and 23 adult cadavers confirms our belief that:

(1) Faulty rotation may account for the left-sided cecum (Walsham and Mayo) and splenic cecum (Keaton).

(2) Fault in normal descent produces the subhepatic ceca (Lockwood, Treves, Farenholt, Hartman, Jonas, and myself), the partial descent (Delbet), or the "high cecum" (Kantor).

(3) Faulty fixation—whether or not by intrauterine inflammation—may account for the veils and folds of peritoneum described by Lockwood and others, or the retroperitoneal and retrocecal appendices of Borders and Eastman.

(4) The right lower quadrant pain associated with displaced ceca (Black, Fowler) can be accounted for by the sensory connections.

(5) The frequency of associated cholecystitis or duodenal ulcer (Carter), or of a symptom-complex simulating them (Kantor) can be accounted for by the venous and lymph drainage (Held), or the sensory connections of the area.

(6) The evidence collected tends to refute the idea of the subhepatic position for the cecum in the new-born and infant up to the fourth month (McConnell, Whitlock, Piersol), and corroborates the observations of MacLean and Hertwig that descent is probably normally begun or accomplished by the eighth month of fetal life.

(7) No evidence of the grossly mobile cecum of Fried was found, but could perhaps be explained by the absence of any degree of fixation.

(8) No positive undescended ceca in the group of new-born examined were found (substantiating MacLean's and Larimore's observations). The series is of course possibly insufficient to question the figures of Smith and Carter as to frequency.

(9) The observations of Bryant on the variation of the infant colon are sustained—and those of Treves questioned.

(10) The study of the problem confirms us more definitely in our previous belief that a complete gastrointestinal study is the just due of the patient. Any curtailment by the roentgenologist bids fair to lead to faulty interpretation and diagnosis.

Fig. 26. Cadaver 2. Elongated, vertical, right-sided sigmoid with long mesosigmoid permitting very free movement of the distal colon. Descendens essentially fixed. (Drawing by Miss Sadler.)

Fig. 27. Cadaver 12. Grossly dilated transverse colon with a relatively small caliber vertical sigmoid on a free mesentery. Liver rotated upward by the large transversus and hepatic flexure. (Drawing by Miss Sadler.)

REFERENCES

Alvarez, Walter C. The Mechanics of the Digestive Tract. Paul B. Hoeber, New York, 1928.

Black, Carl E. Displacements of the colon. *Ann. Surg.*, 1912, *56*, 888–899.

Bryant, John. Observations on the growth and length of the human intestine. *Am. J. M. Sc.*, 1924, *167*, 499–520.

Carman, R. D. The Roentgen Diagnosis of Diseases of the Alimentary Canal. W. B. Saunders & Co., Philadelphia, 1920.

Carter, L. J. Further report on the study of the colon by opaque enema; summary of 1,000 examinations. *Canad. M. Ass. J.*, 1920, *10*, 1112.

Davis, James E. The morphography of 285 colons. *Am. J. Obst.*, 1916, *73*, 474–485.

Delbet, Paul. Ectopie sous-hepatique du caecum. *Bull. Soc. anat. de Par.*, 1897, *51*, 65.

Eastman, J. R. Congenital deformation and defunctionalization of the caudad ileum and colon. *J. Am. M. Ass.*, 1916, *67*, 647–653.

Farenholt, A. An abnormally located cecum. *Boston M. & S. J.*, 1894, *131*, 427.

Fowler, R. H. Persistent developmental anomalies of the large intestine. *Med. Rec.*, 1916, *89*, 353.

Fried, Herman. Roentgenological study of the inverted cecum. Am. J. Roentgenol. & Rad. Therapy, 1928, *20*, 531–538.

Gardner, W. C. Non-descent of the cecum and appendix. *J. Am. M. Ass.*, 1921, *77*, 1652.

Harvey, J. P., Grunwald, J. E., and Kuhlmann, Ch. J. The malformations and displacements of the large intestine. *Am. J. Surg.*, 1926, *1*, 344.

Held, I. W. Chronic appendicitis and its differential diagnosis. *Am. J. M. Sc.*, 1924, *167*, 864–887.

Huntington, George S. The Anatomy of the Human Peritoneum and Abdominal Cavity. Lea Brothers & Co., Philadelphia, 1903.

Jonas, A. F. Undescended cecum and vermiform appendix. *J. Am. M. Ass.*, 1921, *76*, 1821.

Kantor, J. L. Clinical study of some common anatomical abnormalities of the colon. I. The redundant colon. Am. J. Roentgenol. & Rad. Therapy, 1924, *12*, 414–430. II. The low cecum. *Ibid.*, 1925, *14*, 207–215. III. The high cecum. *Ibid.*, 1928, *19*, 101.

Keaton, J. C. Anomalous positions of appendix and cecum. *Radiology*, 1926, *6*, 63.

Kerley, C. G., and LeWald, L. T. Digestive Disturbances in Infants and Children, Roentgenologically Considered. Annals of Roentgenology, Volume III, Paul B. Hoeber, New York, 1923.

Larimore, Joseph W. The human large intestine in the new-born and in the adult. *Ann. Clin. Med.*, 1926, *5*, 439–463.

Larimore, Joseph W. Roentgenology of the colon. Am. J. Roentgenol. & Rad. Therapy, 1928, *20*, 101–113.

Lockwood, C. B. On abnormalities of the caecum and colon, with reference to development. *Brit. M. J.*, 1882, *2*, 574–577.

MacLean, A. Bruce. Undescended caecum. *Glasgow Med. J.*, 1925, *103*, 352–355.

Mayo, Charles H. Failure of the colon to rotate. *Med. Rec.*, 1912, *81*, 401–403.

McConnell, A. A., and Hardman, T. G. Abnormalities of fixation of the ascending colon. *Brit. J. Surg.*, 1922–1923, *10*, 532–557.

O'Hara, Fred S. Malposition of the cecum and ascending colon. *Radiology*, 1926, *7*, 166–167.

Orndoff, B. H. Roentgen-ray studies of the appendix, cecum, and ascending colon. *J. Am. M. Ass.*, 1926, *87*, 1294–1297.

Payne, R. A., and Trahar, F. C. Developmental rests in the cecum and ascending colon and their roentgen-ray diagnosis. Am. J. Roentgenol., 1921, *8*, 643–653.

Piersol, George A. Human Anatomy. J. B. Lippincott, Philadelphia, 1919.

Ranson, Stephen W. The Anatomy of the Nervous System. W. B. Saunders & Co., Philadelphia, 1920.

Roberts, Dudley. Association of obscure abdominal symptoms with nonrotation of the colon. *Am. J. Surg.*, 1920, *34*, 157.

Smith, George M. Statistical review of the common variations in the anatomic positions of the cecum and the processus vermiformis in the infant. *Anat. Rec.*, 1911, *5*, 549–556.

Treves, Frederick. The anatomy of the intestinal canal and peritoneum in man. *Brit. M. J.*, 1885, *1*, 415–419; 470–474; 527–530; 580–583.

Walsham, W. J. Anatomical variations. *St. Bartholomew's Hosp. Rep.*, 1880, *16*, 69.

Whitlock, S. B. Roentgenological study of the large intestine. *Radiology*, 1926, *7*, 218–226.

Vol. XXVI, No. 6

MULTIPLE MANIFESTATIONS OF SUBCHONDRAL NECROSIS*

(OSTEOCHONDROPATHIA JUVENILIS, OSTEOCHONDRITIS, EPIPHYSITIS)

By W. C. MARTIN, M.D., *and* HUGO ROESLER, M.D.

BOSTON, MASSACHUSETTS

DURING the last thirty years, an increasing number of disease entities affecting the skeleton of young growing individuals have been described. They show clinically a benign course and a tendency to heal without treatment. When roentgenologically examined, the lesions occurring in different bones show great similarities. Furthermore, the similarity was made more striking by the studies in pathology by Axhausen. We refer to the diseases described by Calvé, Legg and Perthes, Osgood and Schlatter, Köhler, Keinböck, Preiser, and Calvé. Rare localizations have been reported in the patella, condyles of the femur, apophysis of the calcaneus, astragalus, sesamoid bones, clavicle, capitulum and caput humeri, heads of the metacarpal and metatarsal bones.

The common roentgenographic findings are best understood from a short résumé of the pathological changes found in these lesions. The most extensive and valuable work in this field has been done by Axhausen, whose pathological findings we used to interpret the changes noted on our films. Early one finds primary necrosis of the bone without macroscopic changes in the shape or structure of the bone. Later this is followed by intermeshing and pulverization of the trabeculae associated with hemorrhages. Frequently these changes result in compression fractures. The process of repair is shown by absorption of bony detritus which later leads to the development of defects, deformities, seques-

FIG. 1.

TABLE I

COMPARISON OF PATHOLOGIC WITH ROENTGENOLOGIC FINDINGS

Pathologic Findings	*Roentgenologic Findings*
(a) Microscopic evidence of necrosis without macroscopic changes in the shape or structure of bone.	Negative.
Intermeshing and trabeculation of the trabeculae associated with hemorrhage.	Haziness, fuzziness, sclerosis, condensation, and irregularity of bone structure.
Compression and fracture.	Crumpling and crumbling; fragmentation and fracture; irregularity; deformity; flattening, cleaving and mushrooming.
Absorption of bone detritus associated with cyst formation and sequestra.	Cyst-like areas; areas of rarefaction; decalcification.
Formation of scar and callus tissue, fibrous, osteoid, and cartilaginous.	Mottling and areas of decreased density. Separation and cleavage.
Healing.	Bone may become normal in size, shape, and structure. It may be associated with signs of arthritis.
(b) Joint cartilage not affected.	Joint space normal or increased in width.

* From the Roentgen-ray Department, Massachusetts General Hospital, Boston, Mass.

TABLE II

COMPARATIVE ROENTGENOLOGIC FINDINGS

Localization	1929	1931	Remarks
Both Hips	Joint spaces normal. No generalized bone atrophy.		
	Femoral heads: mushrooming, contour irregular; cysts; sclerosis. Femoral necks: short and broad.	General appearance unchanged. Bony structure more regular. Femoral necks show no change.	Bilateral Perthes—Calvé-Legg. Improved (Fig. 1)
Vertebrae	Intervertebral spaces normal. No generalized bone atrophy.		
	Outline of articular surfaces wavy and irregular. Dorsolumbar kyphosis; 11th dorsal wedge-shaped with a–p diameter one-half normal size. Central bony structure normal. Edges are irregular.	Disappearance of irregularities and defects except those of the 11th dorsal which shows only slight improvement; dense sclerosed edges.	Calvé's disease. Condition improved. (Fig. 2)
Hands	All joint spaces normal. No generalized bone atrophy.		
(a) Carpus.	Right scaphoid: shape abnormal and much smaller in size than the left. Outline sharp. Structure normal. Juxtaposition of small bone fragment.	By 1930, fragment and bone united. In 1931, pea-sized area of haziness. Outline of scaphoid now sharp but irregular.	Preiser's disease. (Fig. 3)
(b) Metacarpals.	Distal articulating ends of the right second and third. Outlines irregular and hazy. Localized fuzziness of bone structure.	Outline still irregular. Articular ends flattened.	One case each by Assmann and Mauclaire. (Fig. 4)
Feet	All joint spaces normal. No generalized bone atrophy.		
(a) Metatarsals.	Right and left first, distal articulating ends. Localized, fuzzy, pea-sized areas showing crumbling of bone structu Demarcated by sclerosis. Irregular articulating edge	Cancellous structure now normal. Residual defect of articulating edge.	One case by Assmann. (Fig. 5)
	Left second metatarsal. Localized sclerosis a. fuzziness at distal articulating end.	Unchanged.	Köhler-Freiberg's disease. (Fig. 5)
(b) Astragali.	Upper articulating surfaces show separation of ovoid-shaped bony particles, 1 cm. in size, sclerotic demarcating zones.	Articulating edges show a saddle-like depression. Contour sharp.	One case described respectively by Deutschländer, Garcia Diaz, Axhausen. Improved. (Fig. 6*a* and *b*)
Clavicles	Not examined.	Both sternal ends cup-shaped; hazy; atrophy; bony separation, left.	Described by Friedrich. (Fig. 7)

Study of the remainder of the skeleton reveals early closure of the epiphyses at the elbows (Fig. 8), knees, os coxae, and proximal ends of the femora.

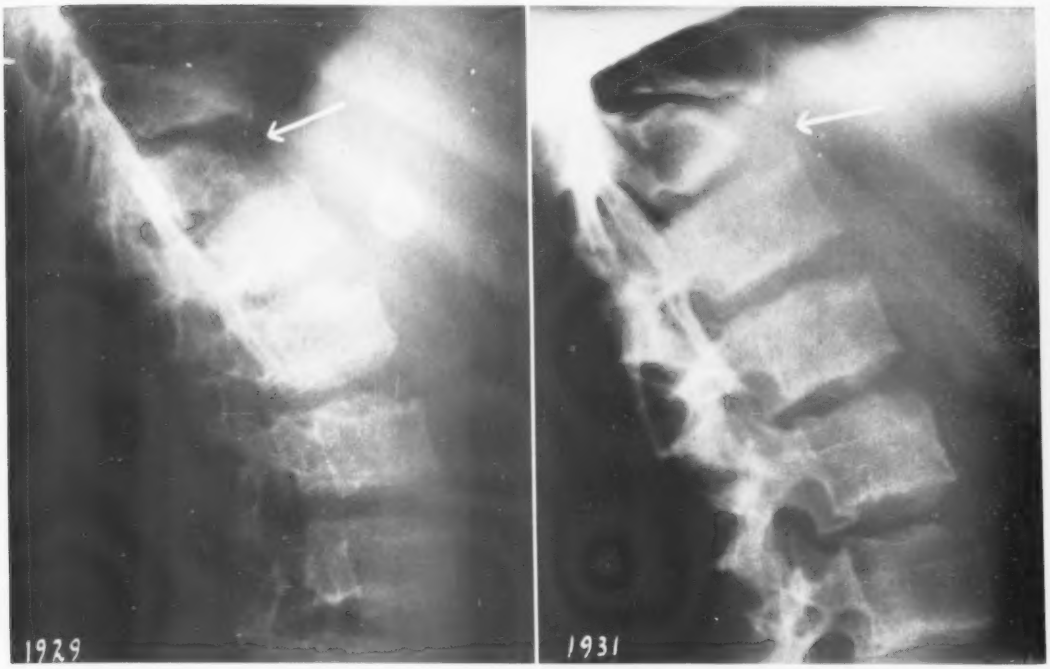

Fig. 2.

Fig. 3

FIG. 4.

tra, and small cysts; also to the formation of scar tissue and callus consisting of fibrous, cartilaginous and osteoid tissue. This repair tissue originates from the joint capsule, periosteum and epiphyseal structures. An important fact is that the process never affects the joint cartilage. Finally, regeneration takes place, frequently with complete healing, but often deformity persists and arthritic changes may develop.

After studying our films and reviewing the illustrations and pathologic findings of the cases reported, we found it possible to correlate in tabular form, the pathologic with the roentgenographic changes (Table I).

SUMMARY OF CASE

No. 132676. Onset at age of eleven. Chief and only complaint was slight pain in the right hip. There was no history of trauma. The first examination made when the patient was twelve years old showed moderate kyphosis at the level of the eleventh dorsal vertebra and limitation of hyperextension of the hips. The examination was negative for localized tenderness, rigidity, or muscle spasm. The patient was always well developed and well nourished. The chest was negative. A spinal fusion was performed at the dorsolumbar region in 1929. Reexamination by Dr. Albright in 1931 for endocrine study showed no evidence of glandular disturbance. The skin, hair, menstrual history, chest, abdomen, nervous system, etc., were negative. Examination of the patient by Dr. Barr of the Orthopedic Service showed excellent posture while standing. When walking, the left hip was held stiffly with slight adduction. There were normal postoperative findings after spinal fusion with fixation of the vertebrae beneath the scar. There was some limitation of motion in both hips. The examination of the remainder of the spine and the other joints gave no evidence of pain, rigidity, or disturbed function.

Detailed Follow-up Examination. Whereas early union of the epiphyses is somewhat suggestive of some endocrine disturbance relavant to the gonads the patient stated that the

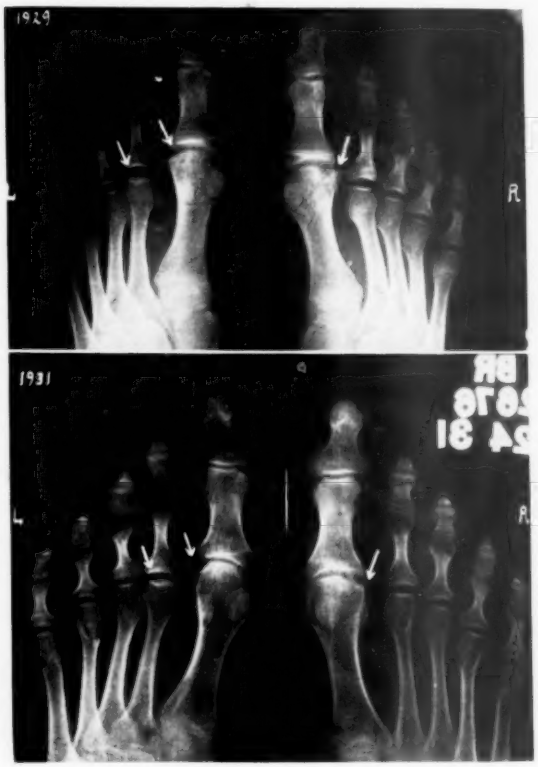

FIG. 5.

menses started at the normal age and were perfectly regular. She likewise stated that she flows normally and gives no other history to suggest endocrine disturbances.

On physical examination, the skin is normally moist; the palms are moist; the neck is negative. The breasts are normally developed and she has normal distribution of body hair. My impression is that the condition is not related to calcium metabolism but is a specific malady affecting the epiphyses. I find nothing to indicate any endocrine disturbances. Calcium and phosphorus in the serum show normal figures, 10.6 and 6.6 mg per 100 c.c. respectively (Dr. Albright).

The patient walks with the left hip stiff in slight flexion and adduction. She stands erect with excellent posture. There is no apparent abnormality on general examination. Motion of the shoulders, elbows, wrists, and fingers is normal and equal on both sides. Motions of the cervical spine are free in all directions. There is a well-healed scar on the midline of the back extending from the ninth dorsal to the third lumbar region. The tips of the spinous processes in the area cannot be felt. Motions of the dorsal and lumbar spine are free and normal except directly beneath the operative incision

Fig. 6*a*.

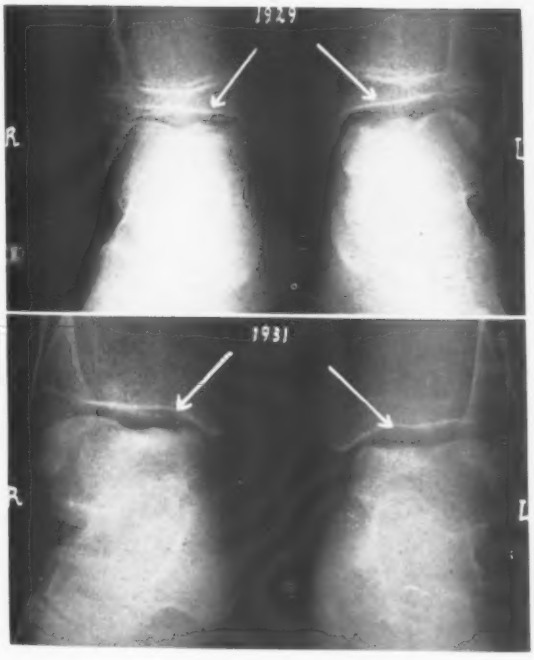

Fig. 6*b*.

Fig. 7.

Fig. 8.

where apparently solid bony fusion is present. With the knees straight, the patient is able to touch the floor with her fingers. The measurement of the right leg is $31\frac{3}{4}$ inches and that of the left $31\frac{1}{2}$ inches. The apparent length of the legs is the same. Motions of the right hip, flexion limited by 20 degrees. There is full extension and normal adduction. The left hip is held in 20 degrees permanent flexion. Motion in flexion to right angle is free and painless. Beyond that point, marked pain is elicited. The total range of motion is probably to 45 degrees beyond a right angle. There is normal adduction, 45 degrees motion in abduction. There is about 10 degrees motion in internal and external rotation. Motion in both knees is free from full extension to full flexion. There is moderate abnormal lateral mobility in both knees. There is no knock-knee or bow-leg deformity. There is a linear scar over the subcutaneous surface of the right tibia which is well healed. No bone irregularity is noted on palpation. Examination of the ankles, feet and toes is negative. Motions are free and equal. Height is 61 inches (Dr. Barr).

DISCUSSION

This case presents a multiplicity of lesions, limited to the subchondral bone. Most all of these lesions have been described as separate bone disease entities. The lesions, when described pathologically, show similar changes, varying somewhat with the stage of the disease. The etiology is still unknown; trauma is still being discussed. When only one lesion occurs in a bone naturally exposed to trauma, the conception of a traumatic etiology is easily understood. However, with the occurrence of a multiplicity of lesions without any history of even the slightest trauma, it seems best to discard the traumatic concept. Later, clinicians brought forward the idea of some inflammatory condition expressed in the term epiphysitis. The pathological reports, however, have shown no evidence of bacterial or inflammatory tissue. Furthermore, the occurrence of the disease in the vertebral bodies as well as in the apophysis of the calcaneus and the tibia could not be included in the term epiphysitis. The term epiphysitis is misleading. Pathologically, the findings varied somewhat with the stage of the disease met with, but the findings always showed subchondral necrosis in various stages of repair.

The similarity of the roentgen findings in these various entities, all localized to the subchondral bone, together with a similar clinical course and similar pathological findings, favors the opinion that they are all one and the same disease with manifestations in different bones. Endocrine disturbances are mentioned and such lesions have been described by both Assmann and Ruggles as occurring in dwarfs. Blood studies by Dr. Albright in this case as well as in others, have revealed no disturbance in the calcium or phosphorus. Multiplicity of lesions may be much more frequent than the literature would lead one to believe as studies of the entire skeleton are only rarely mentioned (Buchman).

The follow-up study of this case seems to prove that the lesions may exist for years without producing any clinical manifestations and that they show a definite tendency to heal without treatment. Thus it would seem best to use only palliative measures until the disease becomes stationary.

REFERENCES

1. ASSMANN, H. Klinische Röntgendiagnostik, 1929, pp. 955, 1008.
2. AXHAUSEN, G. Ueber den Abgrenzungsvorgang am epiphysären Knochen (Osteochondritis dissecans König). *Virchow's Arch. f. path. Anat.* (etc.), 1924, *252*, 458–518.
3. AXHAUSEN, G. Zum Vorkommen des Abgrenzungsvorganges am Fussgelenk. *Zentralbl. f. Chir.*, 1928, *55*, 322–327.
4. BUCHMAN, J. A résumé of the osteochondritides. *Surg., Gynec. & Obst.*, 1929, *49*, 447–453.
5. CALVÉ, J. Sur une forme particulière de pseudo-coxalgie greffée sur des déformations caractéristiques de l'extrémité supérieure du fémur. *Rev. de chir.*, 1910, *30*, 54–84.
6. CALVÉ, J. A localized affection of the spine suggesting osteochondritis of the vertebral body,

with clinical aspects of Pott's disease. *J. Bone & Joint Surg.*, 1925, *7*, 41–46.

7. Deutschländer, K. Zur Kenntnis der gelenknahen Nekrosenherde im subchondralen Knochenmarkraum. *Zentralbl. f. Chir.*, 1928, *55*, 469–472.

8 Freiberg, A. H. Infraction of the second metatarsal bone, a typical injury. *Surg., Gynec. & Obst.*, 1914, *19*, 191–193.

9. Friedrich, H. Ueber ein noch nicht beschriebenes, der Perthesschen Erkrankung analoges, Krankheitsbild des sternalen Clavikelendes. *Deutsche Ztschr. f. Chir.*, 1924, *187*, 385–398.

10. Garcia Diaz, F. Un cas d'ostéochondrite juvénile de l'astragale. *Bull. et mém. Soc. nat. de chir.*, 1928, *54*, 986–988.

11. Köhler, A. Eine typische Erkrankung des 2. Metatarsophalangealgelenkes. *München. med. Wchnschr.*, 1920, *67*, 1289.

12. Legg, A. T. An obscure affection of the hip-joint. *Boston M. & S. J.*, 1910, *162*, 202–204.

13. Mauclaire. Epiphysite des têtes métacarpiennes avec main un peu creuse. *Bull. et mém. Soc. nat. de chir.*, 1927, *53*, 1377.

14. Perthes. Ueber Arthritis deformans juvenilis. *Deutsche Ztschr. f. Chir.*, 1910, *107*, 111–159.

15. Preiser, G. Eine typische posttraumatische und zur Spontanfraktur führende Ostitis des Naviculare carpi. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1910, *15*, 189–197.

16. Ruggles, H. E. Dwarfism due to disordered epiphyseal development. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 91–94.

Vol. XXVI, No. 6

AN UNUSUAL MANIFESTATION OF EPIPHYSEAL AND JOINT PATHOLOGY IN A NEW-BORN INFANT

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DISEASES of the joints which produce abnormal roentgen findings are rare in the new-born. Conditions present at birth can be practically limited to (1) chondrodystrophies, (2) congenital syphilis, and (3) anomalies of development. Diseases of the osseous system, of course, will include other etiologies, but in the following discussion only joint lesions will be considered. This case is cited because of the unusual roentgen findings and as an interesting one from the standpoint of differential diagnosis.

CASE REPORT

Baby B., aged two months, referred by the family physician for roentgen examination because of apparent shortness of the left lower extremity. No other abnormalities or manifestations of disease were noted at the clinical examination. The child was full term and delivered in a normal manner. The family history was negative. This was the first child and the mother states she had had no other pregnancies.

Roentgenograms were made of all the long bones, the pelvis, the skull, and the chest. These show, except for comparative shortness of the left lower extremity, a proportionately normal skeletal development. Almost all the joints show abnormal findings, the left side of the body showing the most apparent changes. These changes consist of multiple, small, bony bodies scattered about the region of the joint. The diaphyses appear smooth at the epiphyseal line, and many of the epiphyses appear ragged. Both calcanei are extremely ragged in contour. Beside the normal birth centers namely, the talus, os calcis, and cuboid in the foot, a ragged navicular center is also present, The talus shows the same ragged borders that are noted in the os calcis. Both lower femoral epiphyses are intact and the right upper tibial is of normal appearance. The left is small and slightly irregular in contour. Both shoulders, but more particularly the right, show similar deposits scattered through the region of the joints. Only traces of the carpal centers are present, and these present an extremely irregular appearance. The skull is normal. The left femur, tibia, and fibula show no apparent reason for the shortness of this extremity. The femur is no thicker than the right, and the epiphyseal end of the bone is not abnormally wide.

The differential diagnosis seemed to lie between an atypical manifestation of congenital syphilis and a curious manifestation of a mild chondrodystrophy. Blood Wassermann tests on the mother, father, and child were found negative. In subsequent correspondence with the physician who referred this patient, it was learned that he had taken care of the maternal grandfather during a recent illness, and that the clinical symptoms were suggestive of a cerebrospinal syphilis. This was not checked by serological examinations because the patient recovered sufficiently to leave that section of the country, and the physician lost all contact.

Congenital syphilitic osteochondritis is, of course, easily recognized by the usually typical picture of multiple joint involvement, gouged out irregularities along the diaphyseal side of the epiphyseal line, the concomitant periosteal changes along the shaft of the long bone, and, in many cases, a transverse band of decreased density through the diaphysis, which is quite typical. This is considerably wider than the so-called Trümmer zone seen in scurvy.

Köhler speaks of the difficulty in diagnosing atypical lues of the new-born, saying that one may see only a few large or small bony fragments and "splintering" near the diaphysis. One infers that he speaks of the diaphyses being the source of the fragments. He shows no illustrations.

Meyer shows roentgenograms of congenital lues in which the typical transverse band of decalcification is present in the metaphysis. The epiphyses in his illus-

Fig. 1. Left ankle, showing the ragged os calcis and the numerous osseous nuclei scattered about the region of the joint.

trations show a jagged contour which may be compared with some of the centers in the case cited.

Kaufmann differentiates three forms of chondrodystrophy, "according to whether the cartilage, unable to produce sufficient longitudinal rows, is otherwise normal (hypoplastic), or is softened (malacia), or rarest, is of normal hardness but grows undisciplined and unprepared for invasion of the marrow, and so that thick, broad, fungus shaped epiphyses are formed on the short diaphyses (chondrodystrophy hyperplastica)." Kaufmann also remarks on the

Fig. 2. Right ankle, showing the ragged contours of the os calcis, astragalus, and navicular.

Fig. 3. Showing the short left lower extremity and the multiple osseous nuclei in the region of the knee-joint.

Fig. 4. Right hand, showing marked irregularity of osseous centers present.

generally frequent clinical mistake of confusing cretinism with chondrodystrophy, perhaps because so little is known of this condition. The endocrine glands have not been shown as the etiology, and are probably not responsible, inasmuch as a unilateral chondrodystrophy is occasionally seen.

Silfverskiöld, in 1925, described an unusual case of chondrodystrophy in a juvenile. He designates this case as a "forme fruste" of chondrodystrophy, which showed "skeletal anomalies such as epiphyseal formations in the foot and hand which normally do not exist, as well as free, extra osseous nuclei in carpus, tarsus, and other locations."

The roentgen findings in summary consist of:

(1) Multiple, small, granular, osseous nuclei scattered about the joint space in most of the large joints, including the spine. These are distinctly separate from the epiphyseal centers for the long bones, some of which show an uneven, ragged contour.

(2) Curiously jagged contours of carpal and tarsal centers, most marked in the os calces.

(3) Short left lower extremity. Measurements are—umbilicus to internal malleolus, 8½ inches, and anterior superior spine to internal malleolus, 7 inches. Right leg measurements are—umbilicus to internal malleolus, 10 inches, and anterior superior spine to internal malleolus, 8½ inches.

These changes would seem to make chondrodystrophy the most likely etiology. The localized malacia in the centers of the hand and foot could easily conform to the pathology of this disease. The lack of periosteal changes and particularly the clean-cut appearance of the diaphyses would appear to rule against even an atypical syphilis. Periodic roentgen examination of this child will be necessary to corroborate the present conjecture.

REFERENCES

1. Köhler, Alban. Grenzen des Normalen und Anfänge des Pathologischen im Röntgenbilde. P. 38.
2. Meyer, Hermann. Röntgen-Diagnostik in der Chirurgie und ihren Grenzgebieten. Julius Springer, Berlin, 1927
3. Baetjer and Waters. Injuries and Diseases of the Bones and Joints. Paul B. Hoeber, New York, 1921.
4. Assmann, H. Klinische Röntgen-Diagnostik der inneren Erkrankungen. F. C. W. Vogel, Leipzig, 1929.
5. Karshner, R. G. Personal communication.
6. Silfverskiöld, Nils. A "forme fruste" of chondrodystrophia with changes simulating several of the known "local malacias." *Acta radiol.*, 1925, *4*, 44–57.

Vol. XXVI, No. 6

METHODS OF MEASURING AND RECORDING ROENTGEN-RAY TUBE CURRENTS AND VOLTAGES*

By CHARLES WEYL, S. REID WARREN, JR., *and* F. MAURICE McPHEDRAN
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Abstract. A system for making oscillographic records of roentgen-ray tube currents is explained. By the use of a high value fixed resistor connected across a roentgen tube, a vacuum tube linear amplifier and an oscillograph, a method of recording the wave shape of the voltage supply to the roentgen-ray tube is described. By means of this same high resistance, supplemented by a vacuum tube peak voltmeter, the peak value of the roentgen-ray tube voltage may be measured more accurately and more conveniently than with a sphere gap.

1. PURPOSE

ELECTRICAL apparatus used for roentgenography of parts of the human body consists, in general, of a system for supplying pulsating current at high voltage and a roentgen-ray tube connected to this source of electrical energy. If the value of the voltage applied to the roentgen-ray tube at any instant is known, the quality of roentgen-ray output at that instant may be estimated accurately provided only that the substance, of which the roentgen tube anode is constructed, is known. To predict approximately the intensity of the roentgen rays at any part of the field irradiated at any instant it is necessary to measure the value of the roentgen-ray tube current at that time. Therefore a continuous simultaneous record of variation of roentgen-ray tube current and voltage during exposure provides data valuable for estimating quality and quantity of roentgen-ray output.

Such records aid in electrical analysis of the apparatus involved. The peak value of the roentgen-ray tube voltage is the factor varied by roentgenologists to control the "penetration" of the roentgen rays. A record of instantaneous values of tube voltage provides a means of accurately measuring this peak voltage. Records of roentgen-ray tube voltage and current taken at the same time may be analyzed to obtain other important data—maximum current and average current through roentgen-ray tube, distortion of wave form of low tension supply by transformer and rectifier system, and exact time of exposure.

It is the purpose of this paper to describe apparatus used for obtaining simultaneously records of roentgen-ray tube voltage and current in order to obtain the data mentioned above.

2. RECORDING OF ROENTGEN-RAY TUBE CURRENT

The Duddell oscillograph† is used for making records of alternating or pulsating current. The instrument will record accurately these currents provided the frequency of pulsation is less than approximately 3000 vibrations per second, and the maximum amplitude of vibration is 10 to 60 milliamperes. The voltage across the oscillograph element is less than one volt. The oscillograph is easily operated and is usually to be found as a part of the equipment of an electrical testing laboratory.

The technique used for roentgenography of parts of the human body usually requires roentgen tube voltages of 30 to 120 kv. peak, depending upon the part to be roentgenographed, while the roentgen tube current may be between 30 and 1000 milliamperes, depending upon the exposure time and the focal-film distance. The frequency of pulsation of tube voltage and current is ordinarily 120 pulses per second,

* The work described has been conducted at the Moore School of Electrical Engineering, University of Pennsylvania, under a grant by the National Tuberculosis Association.

† A description of the Duddell oscillograph may be found in electrical engineering textbooks or handbooks.

since commercial alternating current supply systems usually employ a frequency of 60 cycles per second.

The Duddell oscillograph may be used

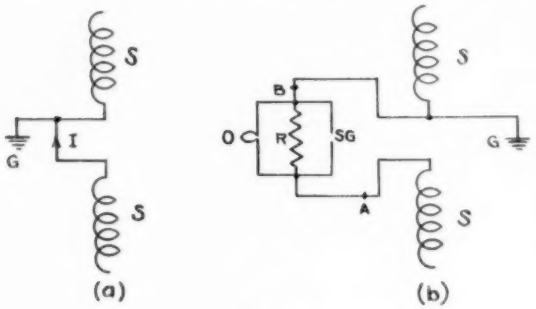


FIG. 1.

to record roentgen tube voltages and currents provided—

(1) That a distortionless electrical network is devised to conduct through the oscillograph element for recording roentgen-ray tube current, that part of the actual tube current necessary to obtain records.

(2) That a distortionless network is devised to give a pulsating current with a maximum value of about 30 milliamperes, the current at each instant being proportional to the roentgen-ray tube voltage at the same instant. This current is used to obtain the oscillographic wave trace of the roentgen tube voltage.

These two networks must be distortionless when considered from two points of view—(a) The connection of the networks

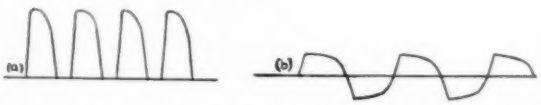


FIG. 2. (*a*) Current *I* pulsating—actual roentgen tube current. (*b*) Current *I* alternating—roentgen tube current with alternate half cycles reversed.

and recording device into the circuit must not disturb the electrical conditions in the roentgen tube circuit. (b) The output current of the networks must be, at each instant, proportional, respectively, to roentgen tube current and roentgen tube voltage at that instant.

The connection of the oscillograph element for recording roentgen tube current is shown in Figure 1.

The high voltage system of the usual roentgenographic apparatus consists of a high voltage transformer secondary in two equal sections, a rectifying system and the roentgen tube. The connection between the two equal secondary windings is grounded to the containing tanks. (See Fig. 1, (*a*).) The current *I* in this circuit is the pulsating roentgen tube current or alternating current representing the tube current with alternate impulses reversed in direction depending upon the connections of the rectifier. Figure 2 shows oscillograms of the current *I*.

Diagram (*b*) of Figure 1 shows the connection for obtaining these oscillograms.

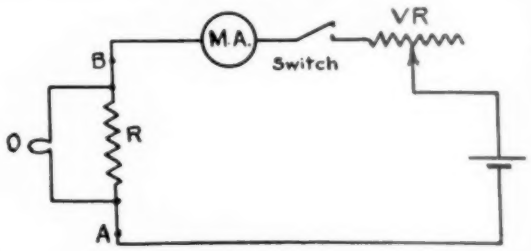


FIG. 3.

Resistance of *R* is less than one ohm and therefore the introduction of the recording apparatus does not disturb the roentgen tube circuit. The oscillograph element *O* is connected across the shunt *R*. A safety gap *SG* is connected to provide an alternate path in case of failure of parts in the recording system. The resistor *R* and oscillograph element *O* are at ground potential, protecting the operator of the recording apparatus.

The curves (Fig. 2) taken by the Duddell oscillograph connected at ground potential in the high voltage circuit, Figure 1, (*b*), may be calibrated. With a given shunt resistor *R* a series of oscillograms is taken. Then a storage battery cell, variable resistor and direct current milliammeter are connected in series with the oscillograph element and shunt as shown in Figure 3.

With the switch open, an oscillogram is taken of the position of the element with

no current flow. This provides a "zero" or "ground" line on the film. With the switch closed, the variable resistor *VR* is adjusted so that a current of 50 milliamperes, as indicated by the meter *MA*, flows through the recording system. A photographic record is taken, giving a line on the oscillogram displaced from and parallel to the ground line. The resistor *VR* is varied to give 100 milliamperes and the procedure repeated until a series of parallel lines is recorded on the oscillograph film. This film, after development, is used to measure the oscillograms of roentgen tube current as shown in Figure 4.

If the frequency of the primary supply voltage for the roentgen-ray equipment is 60 cycles per second, the time of exposure

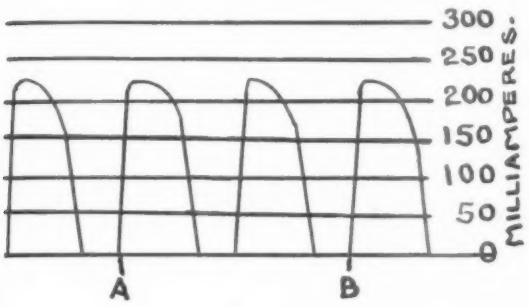


Fig. 4.

may be measured accurately from the oscillogram of the tube current by using as a unit of measurement the distance *AB* (Fig. 4). This distance represents 1/60 second.

3. Recording of Roentgen-Ray Tube Voltages

Recording and measuring roentgen tube voltage is more difficult than recording roentgen tube current. The description is divided into three parts:

a—Resistors—Necessary auxiliary apparatus.

b—Vacuum tube amplifier—To excite oscillograph element for recording voltage waves.

c—Vacuum tube peak voltmeter—For measuring roentgen tube peak voltages.

a—Resistors. Taylor,[1] Terrill and Ulrey,[2] and other investigators, have employed a high value resistor connected across the roentgen tube for studying voltage variations. By reference to the values of roentgen tube voltage and current employed for roentgenography (see Section 2) it will be seen that a resistance of 100 megohms (10^8 ohms) connected across the roentgen tube, will not appreciably disturb the high voltage circuit. Figure 5 shows the method of connection. Since the high voltage supply system has a center tap at ground potential, the point *A* of the 100 megohm resistor will also be maintained at ground potential. Therefore the measuring and recording apparatus are connected at this point for convenience and for safety to the operator.

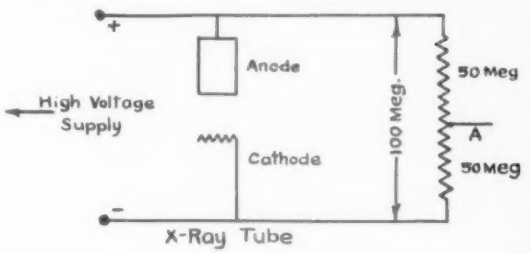


Fig. 5.

Several types of resistors are available for use in constructing the 100 megohm resistor. Precision wire wound units* of one megohm resistance, one watt capacity, may be connected in series to give the total value required. These units are calibrated accurately, do not change appreciably with time or normal changes in temperature, and the inductance and distributed capacitance are negligible at a frequency of 120 cycles per second.

Specially processed carbon resistors may be obtained from several manufacturers. This type usually has a greater temperature coefficient of resistance than the wire

[1] Taylor, L. S. Apparatus for measurement of high constant or rippled voltages. *Radiology*, 1931, *16*, 893–904.

[2] Terrill, H. M., and Ulrey, C. T. X-Ray Technology. D. Van Nostrand Co., New York, 1930, p. 112.

* Units of the Shallcross Manufacturing Company (Collingdale, Penna.) and the International Resistance Company (Philadelphia) have been used successfully. Others of similar construction should prove satisfactory.

wound resistor of the same power rating. If the change of resistance is less than 6 per cent at the rated load of the unit, the error of measurement will be very low because of the characteristic of the circuit used. Carbon resistors are comparatively inexpensive and may be mounted compactly.

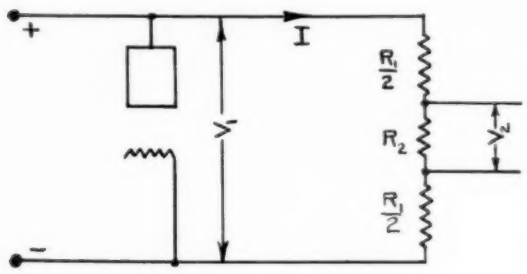


FIG. 6.

Figure 6 shows the actual connection of the resistance bank used, supplemented by the apparatus to be described in succeeding sections, to measure and record roentgen-ray tube voltage.

At any instant the voltage across the roentgen tube is V_1. The resistor of 100 megohms is divided into two sections $R_1/2$ (50 megohms each). An accurately measured resistor R_2 (a resistor of 50,000 ohms was convenient for the work at hand) is connected in series at the junction. At the instant that the roentgen tube voltage is V_1 the current through the resistance bank is I. Therefore—

$$V_1 = (\frac{R_1}{2} + R_2 + \frac{R_1}{2})I$$

and

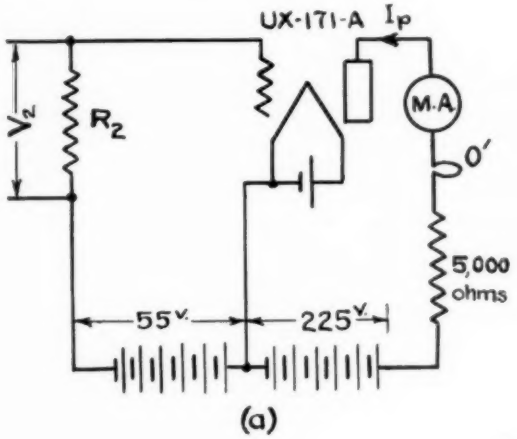
$$V_2 = R_2 I$$

solving these equations for V_1, eliminating I—

$$V_1 = \frac{R_1 + R_2}{R_2} \cdot V_2.$$

If the resistors maintain constant values or if all change by the same percentage of the original values, due to heating, it is seen that the roentgen tube voltage is at any instant equal to a constant multiplied by V_2, the voltage across R_2 at that instant. If the roentgen tube voltage varies with time then the voltage V_2 will vary in a similar manner. Their values at any instant will be proportional, always associated by the constant $(R_1 + R_2)/R_2$.

b—Vacuum Tube Amplifier and Oscillographic Recording of Roentgen Tube Voltage. Referring to Figure 6, it is seen that the value of I for $V_1 = 100{,}000$ volts is approximately one milliampere. That is, the peak value of current in an oscillograph element connected in series with the resistor would be about one milliampere. Duddell oscillograph elements designed to give a deflection of one inch with a current of one milliampere are extremely unstable and difficult to handle because of their delicate construction.



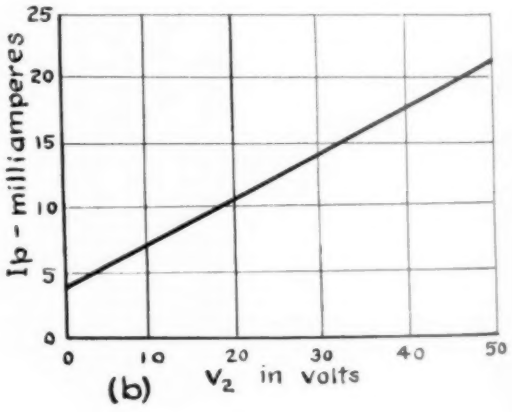


FIG. 7.

To obtain an oscillographic record of the roentgen tube voltage a linear vacuum tube amplifier is employed. This instrument is so designed that the plate current varies in value proportional to the change in grid voltage as the latter varies between the limits of V_2 (Fig. 6). Figure 7 shows the circuit (*a*) employed and the amplifier characteristic (*b*).

When the pulsating voltage V_2 is applied to the input of the linear amplifier the plate current pulsates at the same frequency and the oscillograph element O' deflects in proportion to the value of the roentgen tube voltage.

The element O, Figure 1 (*b*), and the element O', Figure 7 (*a*), are both maintained near ground potential. Therefore they may be contained in the same oscillograph case. They are used to record simultaneously the variation of roentgen tube voltage and current during exposure. A sample oscillogram is given in Figure 8.

Analysis of the voltage wave will provide an index to some of the characteristics of the roentgen-ray apparatus. Figure 9 shows oscillograms of the voltage waves of two machines. Measurement by sphere gap would provide identical peak kilovoltage readings. For a given time of exposure the average voltage of (*a*) is greater than the average voltage of (*b*). For wave shapes of roentgen tube voltages of the types shown, the roentgen-ray output of the tube provides greater roentgenographic film density for a given average voltage than for a lower average voltage, other conditions remaining the same. For machines (*a*) and (*b*) the peak kilovoltage readings are identical, yet roentgenographic tests prove that machine (*a*) is "faster" than machine (*b*).

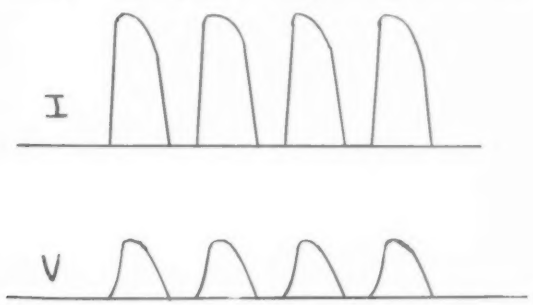


Fig. 8. *V*. Roentgen tube voltage—peak value 60 kv.
I. Roentgen tube current—average value 100 ma.

c—Vacuum Tube Peak Voltmeter for Measurement of Roentgen Tube Peak Voltages. The oscillographic system described above may be calibrated and the oscillograms of roentgen tube voltages may be measured to obtain peak kilovoltage applied to the roentgen tube. The method is tedious and cannot be employed for setting the machine in clinical work because of the time involved. The use of the sphere gap or point gap to measure peak kilovoltage is nearly universal, yet these methods offer definite disadvantages:

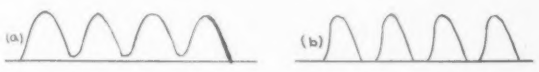


Fig. 9.

(1) Gap readings vary with temperature, pressure and humidity of surrounding air.

(2) A heavy load is placed on the roentgen-ray apparatus after the gap breaks down.

(3) It is difficult to make accurate zero adjustments.

(4) (a) If the gap is adjusted by hand there is danger to the operator. (b) If the gap is adjusted remotely by means of a cord it is difficult to read the gap length.

(5) The size of spheres and kinds of mounting vary so greatly that error may be present due to incorrect calibration.

It is desirable to find a method of measuring roentgen tube peak kilovoltage accurately, easily, quickly, without danger to the operator, entirely independent of surrounding air conditions.

Figure 6 has been reproduced as Figure 10 (*a*) for convenience.

It will be recalled that at any instant

$$V_2 = \frac{R_2}{R_1 + R_2} \cdot V_1.$$

The roentgen tube voltage rises from zero to the peak value and returns to zero during one half cycle. Voltage V_2, during the same time, rises from zero to a peak value equal to (R_2/R_1+R_2) times the peak value of V_1 and returns to zero. Therefore to measure the roentgen tube peak voltage it is necessary to measure the peak value of the voltage V_2 and to multiply this value by the constant $(R_1+R_2/R_2.)$

The vacuum tube may be conveniently arranged to measure the peak value of V_2 accurately. The circuit diagram is given in Figure 10 (*b*).

By describing the use of the peak voltmeter the properties of the circuit will be made apparent. Before the roentgen-ray apparatus is turned on, with no current flowing in R_2, potentiometer B is set at point O. The high resistance voltmeter V reads zero. If the slide of A is set at O the grid has the same potential as the filament. Plate current flows and milliammeter MA indicates the value of this current. Change in position of the slide of potentiometer A to the left brings the grid to a negative potential with respect to the filament, causing a decrease in plate current. The slide of A is moved to the left until a negative grid bias is provided which just reduces the plate current to zero. Under these conditions the application of any alternating voltage, or of any direct or pulsating voltage to R_2 with the polarity shown, causes plate current to flow. If the roentgen apparatus is turned on and a short exposure is made, the milliammeter (of the peak voltmeter) deflects for an instant. If the slide of B is moved from O to the right the grid becomes more negative. A second exposure gives a smaller deflection of the meter MA. Finally B is adjusted carefully to the point nearest O providing no plate current during excitation of the roentgen tube. With no current in R_2 and with the slide of B set at O, A was adjusted for no plate current. Then with current in R_2, B was adjusted for no plate current. Then the *peak* value of the voltage V_2 may be read directly from the voltmeter V. Then from Figure 6,

$$(V_1)_{\text{peak}} = \frac{R_1+R_2}{R_2}(V_2)_{\text{peak}}$$

Therefore the voltmeter V may be calibrated to read in "peak kilovolts." The operation of the instrument is easily mastered. Thereafter the ease of manipulation and consistent results recommends its use.

4. ELECTROSTATIC AND ELECTROMAGNETIC SHIELDING

When apparatus described in preceding sections is used to make measurements and records when the roentgen-ray tube is excited by mechanically rectified apparatus, it has been found necessary to shield all measuring and recording apparatus by enclosing them in grounded metal containers.

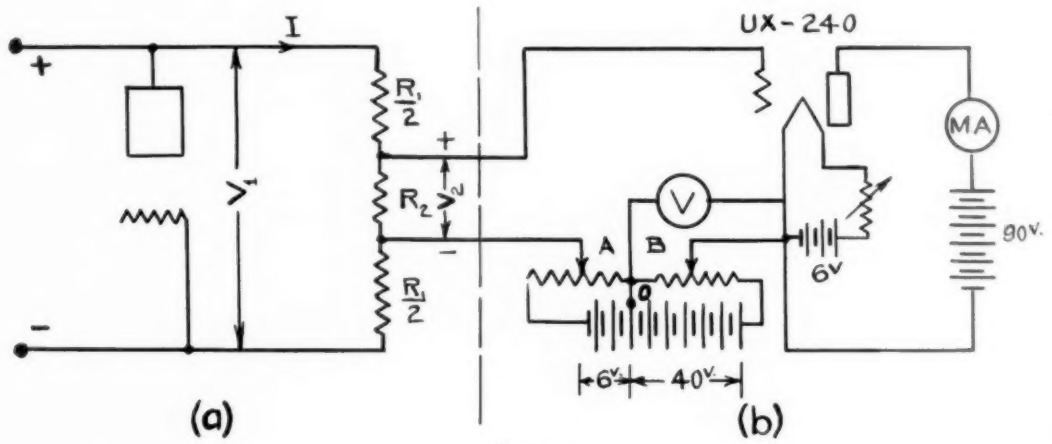


FIG. 10.

The high voltage circuit, with the aid of sparks at the rectifier brushes, provides the necessary conditions for the production of high frequency oscillations which are radiated in a manner analogous to the transmission of radio signals by means of so-called spark transmitters.

The peak voltmeter described in Section 3-*c* is particularly liable to interference from these signals, because of its extreme sensitivity.

The oscillographic recording system for roentgen tube voltage and current may ordinarily be used without shielding since the sensitivity of the apparatus to radio frequency interference is low.

It has been found convenient, in the work for which the equipment was designed, to enclose the resistors R_1 and R_2 in a cage of 18 mesh copper screening. The leads to the roentgen tube are brought from the cage through glass tubes. The leads from R_2 to the measuring and recording apparatus are shielded with copper braid. All the recording apparatus and peak voltmeter are contained in a shielded cage with sheet metal or screening on all six walls.

Acknowledgment. Acknowledgment is made of the able assistance of Mr. C. Justus Garrahan, a graduate student at the Moore School.

Mr. M. E. Nelson, of the Moore School Service Shop, has solved promptly and intelligently many of the mechanical problems involved.

A GRAPHIC METHOD OF RECORDING THE RESPIRATORY EXCURSION OF THE DIAPHRAGM*

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IN MANY chest conditions where roentgenoscopy is impossible, it has been found useful to record the extent of the excursion of the diaphragm during respiration. It has been common practice to expose separate films of the chest at the height of inspiration and at the close of expiration. The amount of movement is then noted by the comparative change in relation to the ribs. However, as the ribs participate in the act and as counting them from the top down is often confusing, this method is frequently unsatisfactory—perhaps misleading.

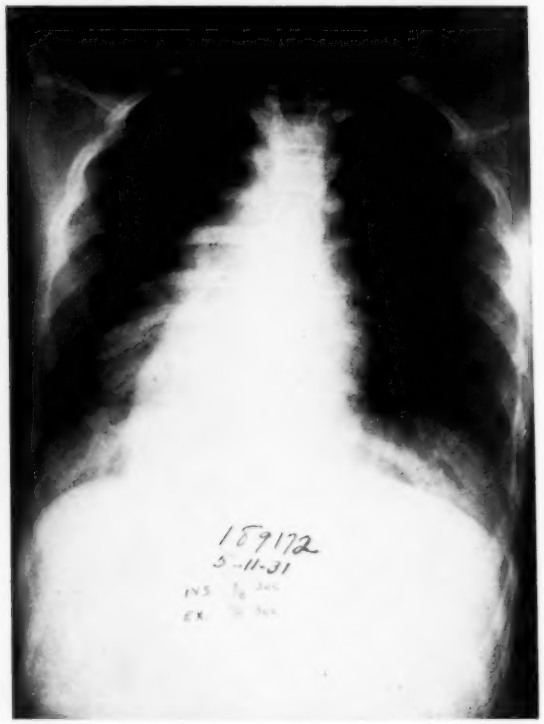

FIG. 1. Normal chest taken with portable technique setting, exposure time of expiratory diaphragm 7/8 sec., inspiratory diaphragm 1/8 sec.

One occasionally observes upon a roentgenogram the outline of the diaphragm in more than one position when movement has taken place during exposure. It was thought worth while to conduct a few simple experiments to determine what alteration of the film-blackening factors would produce upon one film outlines of contrasting densities of the diaphragm at the limits of its excursion.

The diaphragm with its mass of soft tissues beneath affords quite a complete barrier to the quantity of radiation used in chest roentgenography. If, therefore, a record is made of its position first on inspiration, the ascending soft tissues in expiration will preserve the first exposure. Conversely, the elevated diaphragm of expiration will protect a large area of unexposed film for radiation during inspiration.

While the position of the diaphragm in inspiration is thus automatically protected by the tissue densities beneath it, care must be taken that the expiratory record is not lost when the air-filled lung is superimposed. This may be accomplished by cutting down on one or more of the film-blackening factors, during inspiration. As it is axiomatic that equal energy absorption will produce equal blackening of the emulsion, it does not matter in which position the exposure is first made.

As it was felt that this method of recording diaphragm movements would be most valuable in postoperative pulmonary states, a technique which would lend itself to use with a portable outfit was developed. Experiments were conducted varying the time, intensity and filtration (wave length) factors. With a setting of 70 kv. peak, 10 ma. and a distance of 36 inches, a good exposure was obtained of a chest in three-

* From the Department of Roentgenology, Massachusetts General Hospital, Boston. The author is indebted to Dr. George W. Holmes, Chief of the Service, whose interest has made this contribution possible.

quarters of a second. Three alterations of time were then made as shown in Table I.

The total exposure for each film thus was in excess of the amount required. In T1, where the time of both exposures was the same, the ribs appeared equally well in both positions; in T 3, where the diaphragm shadows were most contrasting, there was practically no evidence of the ribs in their inspiratory elevation.

In the next experiment, with the same portable technique of 10 ma., 36-inch distance and a constant time element—one-half second for each phase—the voltage was varied (Table II).

Finally, alteration of wave length was effected by the use of a copper filter. After experiments with various thicknesses, it was found that with the above original setting (70 kv. peak, 10 ma., 36-inch distance and 1/2 sec. exposure made at the limits of each excursion) an excellent record was obtained with the insertion of copper 0.2 mm. in thickness for the inspiratory phase. This method might prove of value with equipment which does not allow adjustment of time or voltage.

It is very likely that for a given equipment variations of the above technique or combination of them, would be found to give equally good results (Fig. 2).

Fig. 2. Another normal chest taken with similar exposure factors as in Figure 1, except the time of 3/4 sec. in expiration and 1/4 sec. with 4 mm. Al filter interposed in inspiration. It is of interest to note the difference in the amplitude of cardiac respiratory excursion in this case as compared with that of Figure 1.

APPEARANCE OF HEART AND RIBS

When the diaphragm shadows are well contrasted, the respiratory excursion of the heart may be noted and an estimate made of the change in its borders and apex position.

With the cutting down of the exposure factor during inspiration only one position of the ribs (expiratory) is to be seen in the views which show excellent diaphragm contrast.

PRACTICAL VALUE OF THE METHOD

Where there is physiological movement of the diaphragm—ascent in expiration and descent in inspiration—there may be obtained on one film with the technique outlined above, a record of the amplitude of diaphragmatic excursion. The amount of movement will be "real" rather than "apparent."

Table I

	Inspiration	Expiration	Appearance of Diaphragm-Expiratory Phase
T 1	1/2 sec.	1/2 sec.	Faint outline only
T 2	1/4 sec.	3/4 sec.	Light uniform density
T 3	1/8 sec.	7/8 sec.	Good contrasting density (Fig. 1)

Table II

	Inspiration	Expiration	Appearance of Diaphragm-Expiratory Phase
V 1	70 kv.	70 kv.	Faint outline only
V 2	60 kv.	70 kv.	Light uniform density
V 3	50 kv.	70 kv.	Good contrasting density

This should be of value in all conditions affecting its movement where roentgenoscopic study is impracticable.

Pathological processes about the diaphragm and similar to it in density will naturally veil its movement.

It should be noted that where there is paradoxical excursion present, only the amplitude of motion of the normal side will be demonstrated by this method.*

As the excursion of the heart during respiration is well visualized, views taken at 7 feet may prove of value in noting the descent of the organ with the movement of its borders and apex.

* An instrument is being devised to record diaphragm action under these conditions and a description of it will be presented at a later date.

SUMMARY

A technique for recording the amplitude of excursion of the diaphragm on a single film is demonstrated. This is attained by altering the exposure time, voltage or wave length factors during inspiration.

The method is of value as routine in checking postoperative complications where roentgenoscopy is not available.

The amplitude of cardiac movement during respiration may also be traced.

Note: Since this paper was accepted for publication it has been brought to my attention that work of a somewhat similar character has been presented by Jung and Van Allen from the Peiping Union Medical College. (A method of recording respiratory movements on a single roentgenogram. *Nat. M. J. China*, April, 1931, *17*, 195–199.

Vol. XXVI, No. 6

RESULTS OF TREATMENT IN 152 CASES OF CARCINOMA OF THE SKIN*

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THIS report includes 152 cases of carcinoma of the skin treated at the Cancer Institute of the University of Minnesota from 1927 to 1930 inclusive. Three types of epithelioma are considered: the basal cell, squamous cell and basal-squamous cell type and they will be taken up in that order.

BASAL CELL CARCINOMA

Basal cell carcinoma, or rodent ulcer, as it is sometimes called, is the most common of the three types. It was described as a clinical entity as far back as 1827 by Jacob, but its origin was not definitely understood until 1900 when Krompecher[4] traced it to the basal layer of the stratum malpighi. His theory has been disputed many times but stands as the one most widely accepted today.

Incidence: The fact that Hazen[3] found the basal cell type to comprise about 1 per cent of all dermatoses and Broders[1] found its incidence to be 12 per cent of a series of 2,000 general epitheliomas proves that it is not an uncommon skin lesion. We have in our study included skin lesions only, excluding epitheliomas of the mucous membrane and lip. In our total of 152 cases the incidence was 83, or 55 per cent. The racial and occupational incidence was not computed in our series but certain definite characteristics have been noted by other observers,[7] namely: (1) The disease is very uncommon among Chinese and Negroes; (2) it is found frequently among the Irish due to fair hair, tendency to freckle, etc.; (3) it is more common among those who lead outdoor lives, as farmers; in Broders' series 56 per cent were farmers; (4) certain types of skin are more susceptible, e.g., the harsh, dry, suborrheic type that does not tan. The ultraviolet ray of the sun is supposed to be the offending agent here.

Sex Ratio: In our series the preponderance of male over female was 4 to 3 and this is in accord with reports of Broders, Schreiner and Wende,[6] Sutton[7] and Williams.[9] Some authors, however, report as high as 2 males to 1 female.[8]

TABLE I

Age, years	Cases
10–20	1
20–30	1
30–40	3
40–50	13
50–60	15
60–70	23
70–80	19
80–90	6
90–95	2
Total:	83

Age Factor: It is generally agreed that the most common age incidence is between sixty and eighty years and that epitheliomas rarely occur before the age of thirty. Our youngest case, which was proved to be a malignant basal cell carcinoma by biopsy, was eleven years old and the oldest ninety-two years, while the average was 64.7 years. The greatest number of cases occurred in the 7th decade of life. The number of cases in each decade of life is shown in Table 1.

Duration: The length of time that the lesion had been present when seen by us was somewhat hard to compute accurately because of the difficulty in determining when a pre-malignant lesion became malignant. Also, some of these cases had received previous surgical and radiation treatment before we saw them which had tided them along for several years in some cases and this would tend to increase the average time for the group. To compensate

* From the Cancer Institute, University of Minnesota, Minneapolis, Minn. Presented before the Tumor Conference, Cancer Institute, University of Minnesota, May 15, 1931, and at a Joint Meeting of the Iowa, Wisconsin and Minnesota Radiological Societies at Rochester, Minn., Oct. 17, 1931.

for these extremes the median as well as the average time was computed.

Average time present when seen: 5.4 years.
Median time present when seen: 4.0 years.

The anatomical location of 88 lesions in 83 patients was as follows:

TABLE II

1. Nose	29
2. Cheek	23
3. Eye	20
4. Temple	7
5. Ear	4
6. Forehead	3
7. Chin	1
8. Shoulder	1

It will be seen from this that only one occurred below the level of the mandible. Broders[1] showed 96 per cent occurring above the clavicle in his series.

Treatment and Statistical Results: The treatments our cases have received have been planned according to the type of lesion and amount of involvement, and no routine treatment has been followed on all patients. The smaller, easily accessible, and earlier lesions have been treated with superficial roentgen rays alone with the following factors: 100 kv., 8 ma., 8 in. (20.4 cm.) target-skin distance, no filter, the dose being from 32 to 40 ma-min. The dose which produces a slight erythema on most patients under these conditions is obtained by 12 ma-min. on a 2×2 cm. field. We refer to this as a skin unit though at many places it is called an erythema dose. With twice this dose (20 to 24 ma-min.) an intense erythema followed by desquamation but usually without any blistering is obtained. It is important to know this upper "safe" limit when skin cancer is being treated and we refer to this as our erythema dose. Lesions in which because of anatomical location, such as across the bridge or tip of the nose, canthus of the eye, etc., it is difficult to get an even distribution of roentgen rays, we have implanted with gold seeds of 1 mc. each of radon. Some few of the small lesions have been treated with a "bomb," which is a small glass bulb containing the radon placed in a special type of applicator. This consists of a small metal container with a brass filter 0.2 mm. thick, which lets through most of the β-rays. The walls and top are lead lined and it is equipped with a long handle. We believe that there is very little difference between the action of roentgen rays and radium and the selection of one over the other is merely a matter of convenience. In very late cases where there is involvement of bone or cartilage any form of radiotherapy may have little effect. The method of choice here is electrocautery with postoperative irradiation. We have only 2 cases, both of which were far advanced, in which it was necessary to use this type of treatment. In treating basal cell carcinoma with roentgen rays we have attempted a cure with the first treatment if possible. However, if any nodule remained in an apparently healed lesion it was retreated after three weeks, one case requiring as high as five treatments to effect a cure. In general, however, if a lesion does not repond in two or three trials to radiotherapy, some other method should be used.

Table III shows the number of cases requiring one treatment or more, and the results.

TABLE III

Treatments	Cases	Lost	Failed	Apparently cured	
				cases	per cent
1	48	8	2*	38	46
2	22	1	1**	20	24
3	11	0	1**	10	12
5	1	0	0	1	1
5+	1	0	1**	0	
Total				69	83

* Did not report for further treatment.
** Very far advanced when first seen.

Deducting the 9 lost cases who are quite likely to be well and 3 cases who were obviously hopeless when first seen by us, gives 97 per cent who apparently are cured from six months to four years. (Table IV

Table IV

NUMBER OF TREATMENTS

Location	1	2	3	5	5+	Failures
Nose	17	6	4	1		2
Cheek	6	8	3			
Eyes	17	4	2			1
Temple	5	2			1	
Chin	2					
Forehead	1					
Neck		1				
Ear		1	2			2

shows location of lesions requiring from one to five treatments.)

In an endeavor to improve our percentage of cures with one treatment we analyzed our cases with the thought in mind of finding a reason for not effecting a cure with a single treatment. We divided the cases arbitrarily into those with a persistence of the lesion and those with a recurrence. If a case was re-treated within three months, we called this a persistence. If re-treated after three months, a recurrence. Table v shows the reason for re-treatment.

Table V

Probable Reason	Recurrence	Persistence
Involved bone or cartilage	2	1
Clinical diagnosis	7 or 50%	15 or 75%
Far advanced		3
Unknown	2	3
Previous irradiation	2	
Persistence of lesion	22	
Recurrence	13	

Thus we found that 75 per cent of the persistences and 50 per cent of the recurrences were cases which had been referred to us for treatment with no microscopic diagnosis. From this we may deduct the advisability of routinely taking a biopsy to determine the type of lesion present,

Table VI

Year	No. Treated	6 months	1 year	2 years	3 years	$3\frac{1}{2}$–4 years	Remarks
1927	12 1 recurrence and re-treated; 1 lost	10	10 1 died*	9 1 died*	8 1 recurrence, not treated $2\frac{1}{2}$–3 yr.	7	Thus of 12 cases, deducting 1 lost and 2 dead, we were able to follow through 9. Seven are living and well at the end of 4 yr. from original treatment. Two died, lesion healed. One lost, 2 recurrences, 1 re-treated, and well at present. Other recurrence not able to return for treatment.
1928	24 5 lost; 3 far advanced; 2 recurrences, not re-treated	14 1 recurrence, re-treated	13 1 died*	12 3 recurrences, re-treated $1\frac{1}{2}$–2 yr.	9		Thus of 24 cases, deducting 5 lost, 3 far advanced and 1 dead (healed) leaving 15 followed through, we have 9 living and well from original treatment at end of 3 yr., 6 recurrences—2 not re-treated and 4 re-treated and well at present.
1929	29 3 lost 1 died*	25 3 recurrences, 2 re-treated	22 2 recurrences, re-treated 6 mo.–1 yr.	20			Thus of 29 cases, deducting 3 lost and 1 dead (healed), leaving 25 followed through, 20 are living and well at end of 2 yr. Five recurrences 4 of which were re-treated and well at present.
1930	23 2 recurrences, 1 re-treated 1 far advanced	20	20				Thus of 23 cases, deducting 1 far advanced, leaving 22 followed through, 9 are well 6–9 mo. and 11 well 12–15 mo., 2 recurrences in first 6 mo.; 1 re-treated living and well and other not re-treated.

* Lesion healed.

whether basal, squamous or basal-squamous, each one of which requires an individual type of treatment.

Table VI shows the number of cases of basal cell carcinoma treated each year from 1927 to 1930 inclusive and the number of cases remaining well the first six months and each year following. If the patient was

TABLE VII

NUMBER OF CASES IN EACH DECADE OF LIFE

30–40	1
40–50	6
50–60	10
60–70	14
70–80	21
80–90	9
Total:	61

lost or died they were deducted at the time lost.

We believe that Table VI is a very convenient method of reporting results in that anyone who is interested can compare their results with ours for each year. As each year passes, one may know at a glance how many one to five year cures he may have. If the patient has a recurrence at any period he is excluded.

SQUAMOUS CELL CARCINOMA*

The treatment and prognosis of squamous cell carcinoma is not nearly as simple as that in basal cell carcinoma. This lesion speedily indurates and ulcerates and in comparison with basal cell carcinoma, which rarely metastasizes, it does so early and therefore the prognosis and results of treatment are not so good. Squamous cell carcinoma is not as common a lesion as the basal cell type. In our series the ratio was 61 to 83, the squamous cell type comprising about 40 per cent of the total number of cases reported. It was twice as prevalent in the male as in the female and occurred more commonly in the eighth decade of life, while the basal cell type was more common in the seventh decade.

* Omitting those of the lip and mucous membrane.

Youngest	30 yr.
Oldest	87 yr.
Average age	70 yr.

The average time that the lesion was present before we saw the patient was three years and the median time was two years, as compared with five and four years respectively for the basal cell type.

Anatomical Location: Whereas 98 per cent occurred above the level of the mandible in basal cell carcinoma, only 77 per cent were found in this location for the squamous cell type. Carcinomas of the trunk and extremities are more apt to be squamous cell than basal cell. In our series of 61 cases with 65 lesions they occurred as follows:

TABLE VIII

1. Nose	17
2. Cheek	15
3. Temple	6
4. Ear	6
5. Post. ear	5
6. Eye	4
7. Forehead	3
8. Hand	3
9. Neck	1
10. Scalp	1
11. Back	1
12. Abdomen	1
13. Leg	1
14. Foot	1

Thus it may be seen that the lesion may occur anywhere on the surface of the body.

Multiple Lesions: Of the 152 cases of epithelioma there were 10 patients with multiple lesions. Three of these patients had multiple squamous cell carcinoma, 4 had both squamous and basal* and 3 cases had multiple lesions of the basal cell type. The cause of squamous cell carcinoma is not known. It is believed, however, that the senile keratosis is a forerunner of the squamous cell while the seborrheic keratosis, if it becomes malignant, usually develops into a basal cell.[7]

The prognosis depends almost entirely upon the stage of the disease at which the patient presents himself for treatment. As

* These are considered both under basal and squamous cell epithelioma.

mentioned before, this lesion progresses very rapidly and metastasizes early in contradistinction to the basal cell type. Once diagnosed, squamous cell carcinoma must be treated very promptly and vigorously and observed frequently following treatment for signs of recurrence.

Treatment and Statistical Results: The treatment of the smaller and earlier squamous cell cancer was carried out in much the same manner as outlined for the basal cell type with the exception that a much heavier dose of roentgen rays was given, the reason for this of course being the increased resistance of this type as compared with basal cell. The usual dose was 48 to 64 ma-min. at 100 kv., 8 ma. and no filter. If the lesion was more infiltrating and penetrating, a 1 mm. aluminum filter was used and the dose increased. If bone or cartilage was involved, cautery excision followed by roentgen rays locally and to the regional glands was the method of choice. Local recurrences were usually treated with roentgen rays. For glandular involvement we prefer either surgical removal or gold implants of 1 mc. each, the dose roughly being 1 mc. to each cubic centimeter of tumor. Table IX shows the number of cases of squamous cell carcinoma requiring one treatment or more, and the results.

The above table shows 6 failures, 5 of which were far advanced. Deducting 10 lost and 5 far advanced cases gives 96 per cent which are apparently cured.

Table X shows the location of lesions requiring from one to five treatments.

The pathological type of lesion according to Broders was not determined in these cases as it has been adopted at the University of Minnesota Hospital only within the last year.

TABLE IX

Treatment	Cases	Lost	Failed	Apparently cured	
				cases	per cent
1	40	8	4*	28	46
2	14	1	1**	12	19
3	4	1	1	2	3
4	1	0	0	1	2
5	1	0	0	1	2
5+	1	0	1*		
Total				44	72

* Far advanced.
** Did not report for treatment.

We believe the reason that we have obtained a higher percentage of cures from one treatment with squamous cell carcinoma than in the basal cell type is that we have known that we had to give a heavier dosage the first time. In treating the basal cell type, because of their relatively slow growth they were treated with the idea

TABLE X
NUMBER OF TREATMENTS

Location	1	2	3	4	5	5+	Failures
Nose	6	7	1	—	—	1	1
Cheek	12	2	1	1	—	—	—
Temple	4	1	1	—	—	—	—
Ear	3	2	1	—	—	—	1
Hand	3	—	—	—	—	—	—
Forehead	2	—	—	—	—	—	—
Post. ear	2	—	—	—	—	—	—
Neck	1	—	—	—	—	—	1
Scalp	1	—	—	—	—	—	1
Back	—	—	—	—	—	—	1
Eye	1	1	—	—	1	—	1
Foot	1	—	—	—	—	—	—
Leg	1	—	—	—	—	—	—
Abdomen	1	—	—	—	—	—	—

TABLE XI

REASONS FOR RE-TREATMENT

Probable Reason	Recurrence	Persistence
Involved bone or cartilage	—	4
Clinical diagnosis	—	6(38%)
Far advanced	—	4*
Unknown	—	2
Previous irradiation	1	—
Not able to return	2*	—
Total	3	16

* Among failures.

that the dose could be repeated if necessary.

BASAL-SQUAMOUS CELL CARCINOMA

In spite of the fact that the transitional form of skin carcinoma was recognized as early as 1879[2] very little seems to be known generally about this very definite and distinct type of lesion. When one reviews the literature, he finds very little written on the subject. Most textbooks on dermatology do not mention the transitional type of epithelioma while textbooks on pathology mention that it occurs occasionally. For that reason this type of lesion will be described more in detail than the basal or squamous cell types.

Montgomery states that in a group of basal cell epitheliomas diagnosed clinically as such, from 15 to 20 per cent will prove to be transitional on microscopic examination.[5] Our group of basal-squamous cell carcinomas amounts to about 10 per cent of the number of basal cells but no doubt some have been missed due to the fact that biopsies were not routinely taken. Of the total number of cases reported here, the incidence of proved cases is 6 per cent. Montgomery, in a series of 119 cases of epithelioma of the skin, showed an incidence of 12 per cent.

Microscopic Picture: Drier has divided the transitional epithelioma into two groups, the mixed and the intermedian.[5] He says as follows:

TABLE XII

Year	No. Treated	6 months	1 year	2 years	3 years	3½–4 years	Remarks
1927	8 3 lost	5	5	5	5 2½–3 yr.	5	8 cases, 3 lost immediately after treatment. Five followed for 4 yr. apparently cured from original treatment.
1928	15 2 lost; 1 died;* 2 far advanced	10 1 recurrence, re-treated	9	9 1½–2 yr.	9		15 cases, 2 lost immediately. Two far advanced, 1 died (healed) leaving 10 followed through. Nine apparently cured end of 3 yr., 1 recurred, re-treated and apparently cured.
1929	22 4 lost; 2 far advanced	16	16 1 died ½–1 yr.	15			22 cases—4 lost immediately, 2 far advanced. One died (healed). Thus 15 followed 2 yr. period, all apparently cured from original treatment.
1930	20 1 lost; 2 recurrences; 1 re-treated	17	17				20 cases—1 lost immediately, 2 recurred in 6 mo. and re-treated and well, others not re-treated, 6 apparently cured 6–9 mo. Eleven apparently cured 9–15 mo.

* Lesion healed.

The mixed has the structure of a basal cell epithelioma but it encloses epidermal pearls. These pearls with a colloidal center and not horny are without keratohyaline and may be called parakeratotic. There is therefore juxtaposition of basal cell and prickle cell tissue but without complete keratinization.

The second type is usually composed of a network of narrow strands made up of only two or three rows of cells. These are larger, lighter and better defined than the basal cells but have neither the dimensions, the structure nor the numerous plain filaments of unions of the prickle cell elements. Moreover, one may find parakeratotic pearls as in the mixed epithelioma. Their protoplasm is but slightly homogeneous at times vacuolated. The nucleus is clear, spread out, budding and multiform with numerous nucleoli.

Montgomery has added two practical points to the above histological description:

1. Many cases in this series show narrow strands of tumor cells infiltrating deeply into the tissues both laterally and vertically. Clinically, therefore, a wider and deeper excision of a transitional epithelioma is necessary to insure complete removal than is the case in the average basal cell epithelioma or squamous cell epithelioma (grade 1 or 2) both of which are usually fairly well defined and circumscribed. 2. Transitional epithelioma should not be confused histologically with the malignant squamous cell epithelioma grade 3 or 4. The prickle cells in the latter, though resembling basal cells, still show more definite spines than the cells of the intermediary type, and are usually larger than these. They are characterized by a single nucleolus in contrast to the multiple nucleoli of the intermedian cell; also, the colloidal center is not seen in the pearls.

Some authorities have advanced the theory that this type of tumor is the result of radiotherapy of basal cell epithelioma and report cases to fortify this belief. Montgomery has studied a series very carefully and was able to demonstrate the basal cell origin in the majority of his cases. He comes to the conclusion, therefore, "that basal-squamous cell epithelioma is a definite microscopic entity. That they represent a metamorphosis from basal cell epithelioma to squamous cell epithelioma and are not dengerative forms of the latter. That they are not necessarily the result of radiotherapy although the latter may be a factor in increasing the malignancy of a tumor in some cases." This series of 8 cases is too small from which to draw any conclusions but as a matter of interest they were analyzed roughly as the other two types.

Of our 8 cases, 7 were male and one female. The youngest case was forty-five and the oldest eighty-two, and the most common age incidence was the seventh decade of life. The average time present was five years while the median was two years.

Table XIII

Year	No. Patients	6 months	1 year	2 years	2½–3 years	Remarks
1928	4	3	3 1 recurrence	2 1½–2 yr.	2	One case far advanced. One excised following treatment. One recurred and not re-treated.
1929	1	1	1 6 mo.–1 yr.	1		This case recurred in 1931 and was recently re-treated with gold implants of radon.
1930	3 1 died	1	1			One far advanced. One died cause unknown.

The treatment of these cases has been carried out in much the same manner as in the squamous cell type but in going over our cases we have come to the conclusion that we must in the future treat a much wider area of apparently normal tissue than we have in the past.

Epitheliomas Treated with Combination of Surgery and Irradiation: Twenty-two cases received a combination of surgical and radiation treatment. The results of these are as follows:

Basal Cell: Two cases both far advanced given surgical cautery and postoperative irradiation. Both failures.

Squamous Cell: Eighteen cases.

1. Early cases with surgical excision and postoperative roentgen treatment well now from six months to four years—6 cases.

2. Early cases excised surgically with recurrence, later treated with roentgen radiation and well now six months to four years. —2 cases.

3. Far advanced cases treated with surgery and radiation—4 cases, all failures.

4. Early cases treated with surgical excision with recurrence. Sent in for radiation treatment when far advanced—3 cases.

5. Far advanced. One case treated with roentgen rays and radium and lesion healed but found it had extended into parotid gland which was then excised with cautery. One year has elapsed with no recurrence.

6. Received irradiation first and surgical excision later because of involvement of cartilage—2 cases, both well six months to two years.

Basal-Squamous Cell: 2 cases.

1. One case far advanced—cauterized surgically—failure.

2. One early case treated surgically twice at University Dispensary with recurrence. Came to us far advanced—failure.

SUMMARY AND CONCLUSIONS

1. The epitheliomas have been considered under three headings: basal, squamous and basal-squamous, or transitional, cell epitheliomas.

2. Six per cent of lesions diagnosed clinically as basal cell were proved to be basal-squamous by biopsy. Probably the incidence was higher as other authors state that 15 to 20 per cent belong in this group.

3. Due to the above fact and also to determine radiosensitivity biopsies should be made on all suspicious lesions.

4. Basal-squamous cell carcinoma requires a heavier dose than basal cell and a wider area must be treated.

5. Basal cell carcinoma practically never metastasizes. If metastasis does occur, the growth probably will prove to be the mixed cell type.

6. Multiple lesions of either or both types may occur on the same patient.

7. The main type of treatment used has been roentgen therapy with a potential of 100,000 volts and no filter. Radium has been used in some few instances. For some lesions both surgery and radiation have been employed and these cases have been discussed separately.

8. We wish to emphasize that no routine treatment has been used but each case has been individualized and treated accordingly.

9. Slightly over 50 per cent of the patients followed have been cured (permanently) with one roentgen treatment. It seems probable that a higher percentage of cures from one treatment can be obtained if the initial dose is increased on an average by 4 to 8 milliampere-minutes.

10. One hundred and thirty-three patients are still reporting occasionally for examination and of these 69 basal cell, 45 squamous cell and 5 basal-squamous, or a total of 119 (90 per cent), have remained well from six months to four years. Nineteen patients were lost and 14 patients were classed as failures. Of the failures 10 were far advanced when first seen.

11. If cutaneous epitheliomas are diagnosed early and receive a proper initial treatment, they should practically all be cured by means of roentgen or radium therapy except when cartilage is involved, in which case surgery is clearly indicated.

REFERENCES

1. Broders, A. C. Basal-cell epithelioma. *J. Am. M. Ass.*, 1919, *72*, 856–860.
2. Fox, W. T., and Fox, T. C. Rodent ulcer. *Tr. Path. Soc. Lond.*, 1879, *30*, 360–370.
3. Hazen, H. H. Textbook of Dermatology. C. V. Mosby Co., St. Louis, 1916.
4. Krompecher, E. Der drüsenartige Oberflächenepithelkrebs. *Beitr. z. path. Anat. u. z. allg. Path.*, 1900, *28*, 1–41.
5. Montgomery, H. Basal-squamous cell epithelioma. Thesis for Master of Science Degree in Dermatology, University of Minnesota, 1926.
6. Schreiner, B. F., and Wende, R. C. The cure of basal cell epithelioma. *J. Am. M. Ass.*, 1930, *94*, 1475–1480.
7. Sutton, R. L. Jr. Rodent ulcer. *J. Missouri M. Ass.*, 1930, *27*, 103–112.
8. Sweitzer, S. E. Skin cancer. *J. Am. M. Ass.*, 1917, *69*, 179.
9. Williams, A. Radium treatment in skin cancer and borderline malignancies. *Radiology*, 1930, *14*, 45–54.

DEEP ROENTGEN-RAY BURNS*

(WITH A NOTE ON BURNS CAUSED BY RADIUM)

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INTRODUCTION

THE purpose of this communication is to stress the danger of roentgen-ray burns and to urge the necessity of treating such burns radically.

My knowledge of roentgen rays and radium is almost entirely confined to the care of burns caused by these agents and seeing so many of the disastrous effects, naturally I am particularly concerned with trying to impress on those who use these agents the fact that burns may and do occur. I also feel that it might not be amiss even to warn patients, who are to be treated, that burns are possible.

There is no question of the vast amount of good done and the remarkable cures effected by roentgen rays when used therapeutically, but the fact should be emphasized that there is another side to the question, and that frequently instead of a cure a burn results which is in many instances far worse than the original lesion.

With the present knowledge of the measurement of the dosage of roentgen rays, and with the methods of protection now available for operator and patient, roentgen burns should become less and less frequent. As a matter of fact, this does not seem to be the case as I am seeing more of these burns each year, and no doubt the same thing is happening to others who are interested in this aspect of the subject.

A number of questions arise in the minds of those of us who frequently see roentgen burns, and I will ask a few of them here. Do those who should know, fully realize the dangers of roentgen rays, or does their enthusiasm blind them to these dangers? How many of you are teaching the young men being trained in roentgenology the dangers of the agent they are using? Has any roentgenologist who is active in his work gone through his career without causing a deep roentgen burn? How many physicians who refer their patients to those who use roentgen rays for therapeutic purposes know what the ultimate outcome is, as far as tissue changes are concerned? Does the roentgenologist himself realize that he may have burned certain patients and that they have never returned to him for treatment? Does the agent who sells the physician his first roentgen-ray outfit stress the danger of its use both to the operator and the patient? Why do we so often hear the term over-irradiation when in reality the lesion may be and frequently is a deep roentgen burn?

A careful consideration of these questions and what follows may stimulate some interest in the risks of roentgen rays, which risks are frequently minimized. The majority of roentgen burns seen today follow the therapeutic use of the rays in dermatologic and other clinical conditions. Some follow the prolonged use of the roentgenoscope and others are due to over-exposures by unskilled operators. I also frequently see burns originating in beauty parlors where roentgen rays are used to remove hair from the face and arms. Surely such dangerous agents should not be in the hands of ignorant attendants who have little realization of the risk of causing burns even if the patrons of such places are stupid enough to allow roentgen-ray treatments when they are suggested. To these may be added a group of burns which occur in spite of the most careful exposures administered by skilled roentgenologists.

With a modern machine, there is little danger in taking a simple plate if ordinary precautions are used. However in the long-continued use of the roentgenoscope, there is a distinct risk and in the therapeutic use of roentgen rays there is considerable danger of burns occurring. It is

*Read before the Southern Surgical Association, Dec. 8-10, 1931.

essential that every effort should be made during both superficial and deep treatments to measure the dose accurately and to protect the surrounding and underlying normal tissue, otherwise these tissues may be greatly damaged. In the growing period, in addition to actual injury to the tissues, retardation of the growth of the bone, cartilage, glands, such as the breast, and other organs may occur.

Except in instances where definite burns have already occurred, we do not yet know what damage may be done to overlying healthy tissues following deep roentgen therapy, as it may be years before such damage manifests itself. I have come to the conclusion after seeing a very large group of deep burns that this agent *should be used for therapeutic purposes, only by experts, and then with the utmost caution.*

The methods of protection for the operator have been of great use but still we quite frequently see burns on the hands of operators who are either careless, or who do not realize the importance of protecting themselves, or who have not been warned of the dangers of roentgen burns. In fact, a goodly number of those who have these burns, especially on the hands, are doctors or dentists.

The susceptibility of the skin of certain individuals to roentgen rays is a matter that should be considered as it may have a definite bearing on the occurrence of burns.

Severe burns may follow single treatments, but they are usually caused by multiple exposures. A peculiarity of roentgen burns is that weeks, months and even years may elapse before the extent of the injury becomes apparent. This is due to a progressive slow obliterative endarteritis of the arterioles in the skin and subcutaneous tissue of the irradiated field, which leads to gradual and fatal ischemia and nutritional disturbances.

Many of the burns do not completely change the full thickness of the skin, and with proper local treatment will take care of themselves. However, quite frequently the skin and varying depths of the underlying tissues are involved and disastrous consequences follow. We will consider only the deep burns.

CLINICAL CHARACTERISTICS

The depth of the burn may vary in different portions of the affected area. The clinical appearance is somewhat as follows. The burned area is often tightly adherent to the underlying tissue and may be somewhat depressed. There are usually patches of keratosis and one or more chronic ulcers which may be superficial, or may involve the full thickness of the skin and also a considerable depth of the underlying soft parts. Some of these ulcers heal very slowly and break down again and repeat this process, while others never heal without operative intervention. The non-ulcerated and healed portions are hairless and atrophied; sometimes wrinkled and sometimes smooth; usually dry and shiny and may or may not have blotchy brownish pigmentation. In the majority of instances, there are characteristic telangiectases which may be discrete or may occur in patches.

The edges of the ulcers are thickened and hard, greyish-red and frequently everted and often give the impression of malignancy. The floor of the ulcer is covered with a mass of tightly adherent yellowish-white necrotic tissue.

The outline of the involved area both laterally and vertically is without definite limitation, and it is impossible to tell the depth of the destructive process until exploration is done. The changed tissues are very hard; the subcutaneous fat may be completely destroyed; the muscle may be infiltrated, or entirely replaced by scar tissue; there may even be marked necrosis of the underlying bone. Extreme sensitiveness is characteristic of the deep burns regardless of their size. The burning boring pain in the ulcerated area is intense and may be due to irritation of the nerve endings caused by infection; to changes in the nerves themselves caused directly by the rays, or by the progressive obliteration of the blood vessels; or to pressure on the nerves by scar. Any one or all of these conditions may exist.

MICROSCOPIC CHARACTERISTICS

There is keratosis at the edge of the ulcer with atypical down growth of epithelium, with or without pearly body formation; a very superficial zone of cellular granulation tissue; unusual scar tissue formation which, as a rule, extends to and involves the muscles; thickening of the blood vessel walls with endothelial obliteration. The hair follicles, the sweat and sebaceous glands are destroyed.

TREATMENT

When a patient with a deep ulcerated burn comes for treatment, should we continue local applications with the addition of rays of various kinds, or should we resort to radical surgical measures? Long experience has convinced me that the problem is essentially surgical. The burns that come to me are usually of long duration and are those on which everything has been tried, including ultraviolet rays, radium and even more roentgen rays. It is possible that ultraviolet rays and radium may be of value in the treatment of roentgen-ray burns in which tissues have not been completely changed, but in deep chronic burns it seems to me to be utter nonsense and poor reasoning to employ other rays to restore tissues that are already completely changed by the original roentgen burn. Usually in the deep burns the condition is simply aggravated by such treatment and subsequent surgical intervention is made more difficult.

I am convinced that when a deep burn has become definitely established, and the ordinary local methods have been tried for a reasonable time without success, excision with tissue shifting is the method of choice; in fact, is the only method promising relief from the actual lesion as well as from the danger of subsequent malignant degeneration. I feel very strongly on this subject as each year I see a number of physical wrecks caused by the long-continued improper treatment of these burns.

METHODS

General anesthesia is usually necessary on account of the nervous and depleted condition of the patient. The burned area should be excised as completely as its location will allow, out to and down to healthy tissue. If the burn is small and in a favorable position, it may be completely excised using an elongated elliptic incision, and the edges sutured. An area of changed tissue which is movable over the underlying base may be treated by gradual partial excision with closure, and by this method the whole area may in time be removed, leaving eventually a comparatively inconspicuous comfortable scar.

Where gradual partial excision is impractical, the burned area should be excised as completely as the location will allow. Occasionally after excision of an extensive deep burn, immediate skin grafting can be done if the exposed tissues are fairly normal. However if the circulation is poor, or oozing cannot be completely checked, the wound is dressed with a material which will not adhere and pressure is applied for forty-eight hours. Then after the continuous application of compresses saturated with normal salt or boric acid solution, the granulations will be ready for grafting in a few days. The type of graft used either for immediate grafting or after granulations have formed should depend on the location of the lesion. For immediate grafts, I usually prefer a thick Ollier-Thiersch, or a whole thickness graft; on granulations small deep grafts have been most satisfactory in my hands, although Ollier-Thiersch and whole thickness grafts may also be used on undisturbed healthy granulations and will take. Where deep depressions are present, or in exposed positions where a pad of fat in addition to the whole thickness of the skin is necessary, I use pedunculated flaps from adjacent unchanged tissue, or from a distant part.

REMARKS

Pain and loss of function are very marked even in a small burn. In the majority of instances, we can promise that with the excision of the burned area the characteristic pain will cease permanently. The tendency to malignant degeneration in chronic roentgen burns is important.

Malignancy is more likely to occur in those instances in which there have been many exposures over a long period of time, rather than from a single massive dose or a few exposures at short intervals.

Ulceration of a patch of keratosis, or the breaking down of areas of chronic roentgen-ray dermatitis should be viewed with suspicion. When a biopsy shows malignancy then the glands draining the part should be removed as well as the lesion itself. Amputation may be necessary in severe cases.

How may roentgen burns be reduced to the minimum? By educating those who use the rays to realize the possibility and danger of burns; by developing better protection for patient and operator; by limiting the indiscriminate sales of apparatus to irresponsible operators; by educating the public.

RADIUM BURNS

There are many marvellous cures which may be attributed to radium but there are also many deep burns caused by the same agent. Those who use radium are as a rule even more optimistic as to its efficiency as a curative agent than those who use roentgen rays and in my experience they seldom, if ever, mention to the patient the possibilities of a burn.

Many of the questions previously asked in regard to roentgen rays apply equally to radium and much that has been said about roentgen-ray burns may be reiterated when speaking of radium burns. Fortunately radium is still too expensive for general use, and that is the only reason why there is any limit to the number of burns caused by it.

The appearance of skin deeply changed by radium has many things in common with the changes made by roentgen rays, and often it is difficult to differentiate the lesion except by the history. I see quite frequently patients who give a history something like this: A small precancerous or even cancerous lesion on the cheek, lip or nose. Several treatments with radium follow. The lesion may or may not be cured but in the process the involved tissues and the tissues in the neighborhood are badly burned and entirely sloughed out, leaving a fistula into the nose through the bone, or through the cheek, or a badly deformed lip. All of these are complicated by marked scarring and radiation changes of the surrounding tissues either superficial or deep. In many of these cases desiccation, or better still, excision with a scalpel or cautery knife, with a wide margin, laterally and deeply, followed by immediate closure if in a favorable position, or by covering the defect with a skin graft, would have effected a cure in a short time with a comparatively inconspicuous scar, and the patient would have suffered none of the subsequent effects of the burn.

In other words, many patients treated with radium for one trouble or another may be deeply burned, and are frequently compelled to undergo long and serious operative reconstruction before they can resume their normal life. Cannot these radium cures be effected, if more care is taken, without this destruction of tissue which is often out of a proportion to the seriousness of the original lesion?

The methods of treatment previously described for roentgen-ray burns should also be used in treating deep radium burns.

CONCLUSIONS

Deep roentgen-ray burns occur much too frequently and the danger of causing such burns should be stressed rather than minimized. The destructive powers of roentgen rays and radium are very great and must be considered as well as their curative powers. There is no question that therapeutically, at least, these agents should be used only by experts and even then with the utmost caution.

Early and wide excision of deep burns caused by roentgen rays or radium with closure of the defect thus made, by tissue shifting, promises more surely than any other method yet devised the elimination of pain, an excellent prospect of permanent healing, in many instances the restoration of function and in addition gives a reasonable assurance of safety from subsequent malignant degeneration.

CONGENITAL ATRESIA OF THE ESOPHAGUS

CASE REPORT

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NEW YORK CITY

THE following case is reported, not because of the rarity of the condition but because of the unusually good roentgenographic examination that was possible. This case forms one of a group of eight that have been very intensively studied at Mt. Sinai Hospital, both from the pathological and clinical aspects, and which, along with an exhaustive review of the literature, form the subject matter of two articles about to be published.[1] No attempt will be made at this time therefore to do more than present this case and suggest the more important references in American roentgenological literature.[2,3,4,5]

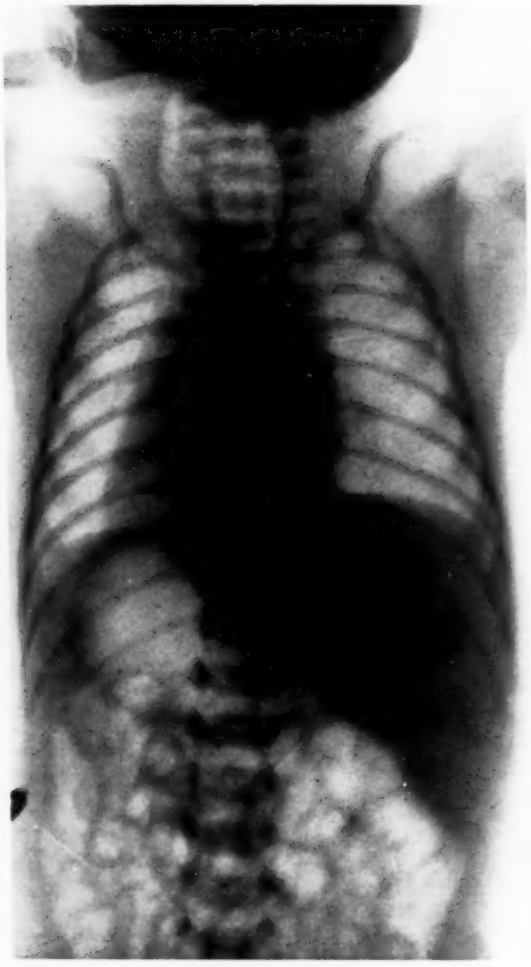


FIG. 1. Preliminary anteroposterior view of the chest.

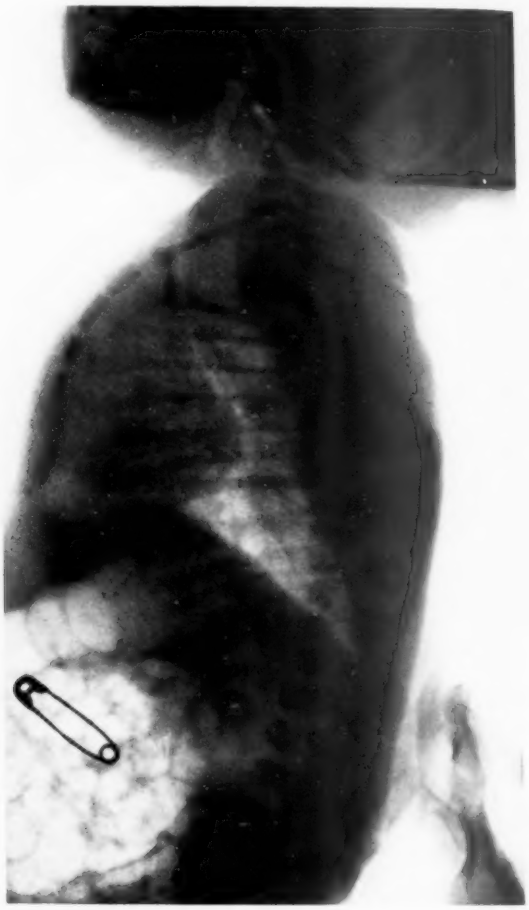


FIG. 2. Lateral view of the chest.

Baby D. was brought to the Hospital one day after birth. The baby was full term, normal delivery, birth weight unknown. There was no history of cyanosis or difficulty in breathing at birth; the child's cry was apparently normal. Several hours after delivery, however, it was noted that the child became cyanotic

FIG. 3. Passage of catheter obstructed at level of jugular notch.

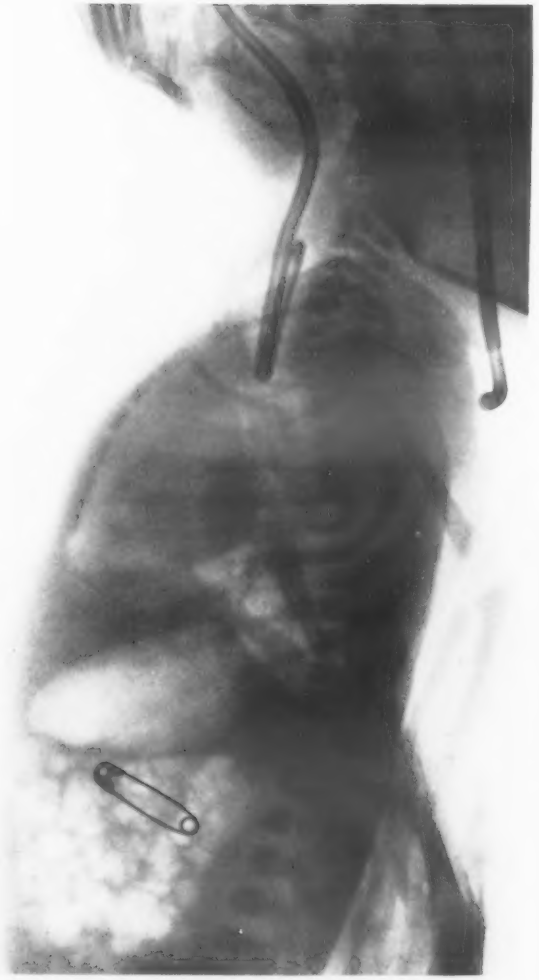


FIG. 4. Catheter turned back on itself.

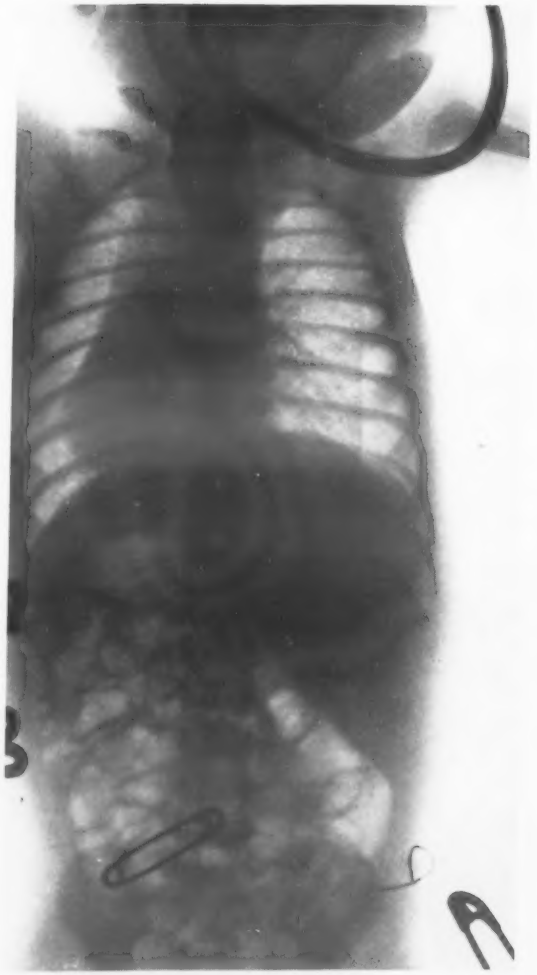


FIG. 5. Anteroposterior view after injection of lipiodol through catheter.

FIG. 6. Lateral view after lipiodol injection.

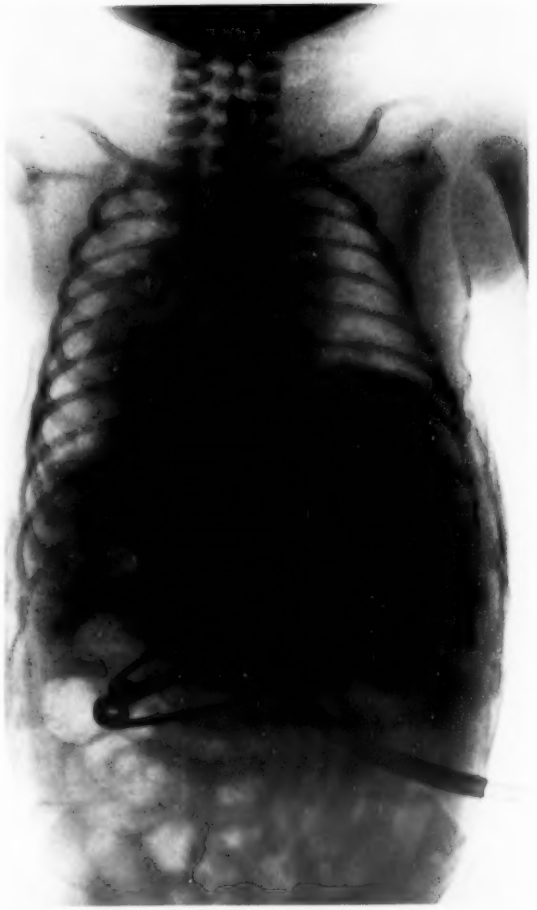


FIG. 7. Residue of lipiodol in atretic sac after eighteen hours.

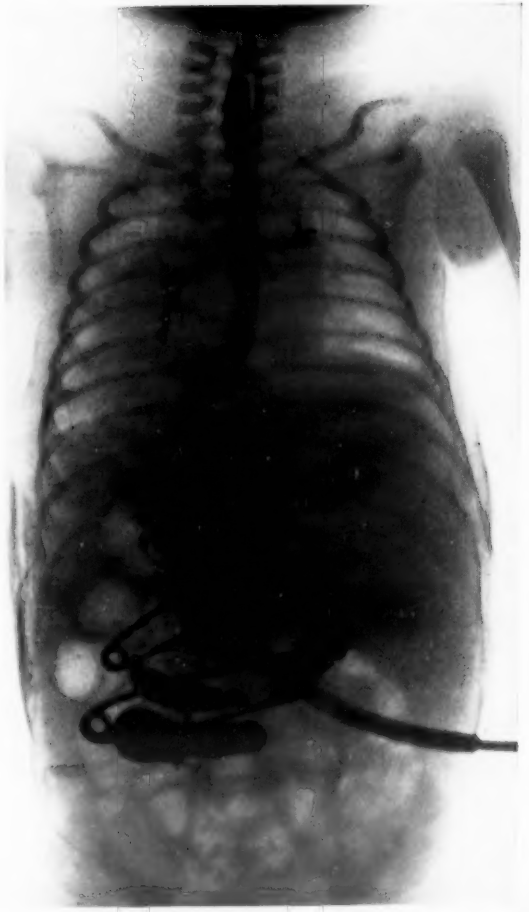


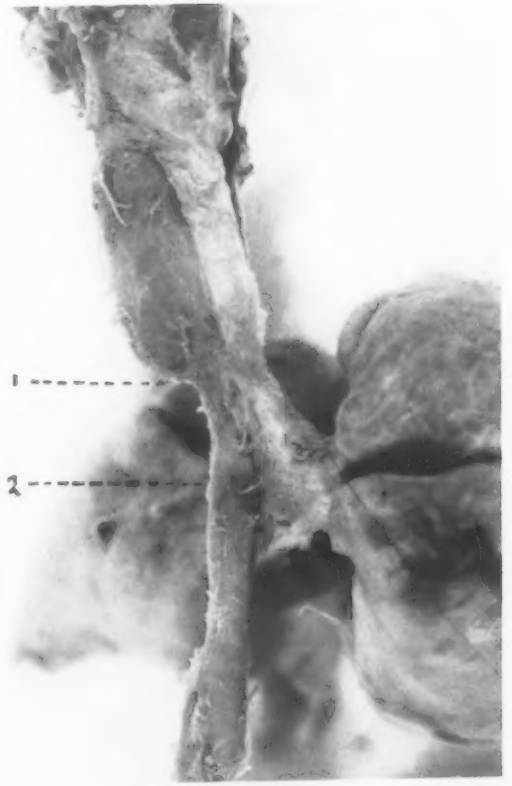
FIG. 8. Anteroposterior view after injection of lipiodol through gastrostomy tube (post mortem).

FIG. 6. Lateral view after lipiodol injection.

FIG. 7. Residue of lipiodol in atretic sac after eighteen hours.

FIG. 8. Anteroposterior view after injection of lipiodol through gastrostomy tube (post mortem).

FIG. 9. Lateral view after lipiodol injection through gastrostomy tube (post mortem).



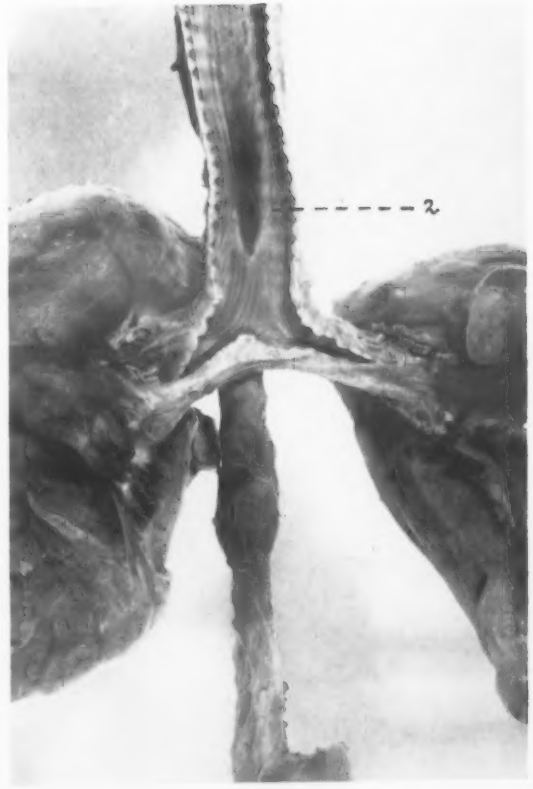


FIG. 10. Anatomical specimen (anteroposterior and lateral views). 1. Atretic end of upper esophagus. 2. Entrance of lower esophagus into trachea.

after attempts to swallow small amounts of water and attempts at crying. The cry became weak and associated with an inspiratory whoop. This occurred with every attempt at feeding. There was no associated vomiting nor paroxysmal cough; no convulsions nor twitchings.

A clinical diagnosis of congenital atresia of the esophagus was made. The baby was brought to the department for roentgen studies in order to eliminate other possible causes of obstruction, and to confirm the diagnosis if possible. Anteroposterior and lateral views of the chest (Figs. 1 and 2) showed a large collection of air in the cervical region, retrotracheal, pressing the trachea forward and compressing it. Heart and lungs showed no abnormality. Considerable gas was noted in the stomach and bowels. A catheter was then passed through the mouth into the esophagus, without difficulty; an obstruction was met at about the level of the jugular notch. Control fluoroscopy showed the catheter to be turned back on itself (Figs. 3 and 4). Injection of lipiodol through the catheter confirmed the impression that there was a complete atresia of the esophagus at the level of the jugular notch (Figs. 5 and 6). In view of the presence of the large amount of gas in the abdominal viscera, the presence of a connection between stomach and trachea had to be assumed. As a last resort gastrostomy was performed but as was anticipated, the procedure was of no avail and the patient died shortly after the operation.

Before post-mortem examination the baby was brought to the roentgen department again for further study. A plate taken at this time (Fig. 7) showed a small amount of remaining lipiodol in the atretic sac; the gastrostomy tube was seen in situ. Lipiodol was injected into the gastrostomy tube and the pictures reproduced in Figures 8 and 9 were obtained. Lipiodol flowed freely through the cardiac orifice of the stomach into the lower end of the esophagus and thence directly into the trachea and bronchial tree. In the lateral plate, therefore, there is seen the atretic upper end of the esophagus, and the lower end of the esophagus connected directly to the trachea.

These roentgen findings were exactly confirmed at autopsy. There were found atresia of the esophagus with communication of the distal portion of the trachea; patent ductus arteriosus; patent foramen ovale; congestion of the liver; status after gastrostomy. A photograph of the specimen is appended (Fig. 10).

REFERENCES

1. ROSENTHAL, A.
ROSENTHAL, A., and HIMMELSTEIN, U. Articles on congenital atresia of the esophagus. To be published.
2. BROWN, R. M. Congenital deformity of trachea and esophagus. *Radiology*, 1926, *6*, 166.
3. KERLEY, C. G., and LEWALD, L. T. Digestive Disturbances in Infants and Children. Paul B. Hoeber, N. Y., 1923.
4. SKINNER, E. H., Congenital atresia of the esophagus. AM. J. ROENTGENOL., 1921, *8*, 319–320.
5. VOGT, EDWARD C. Congenital esophageal atresia. AM. J. ROENTGENOL. & RAD. THERAPY, 1929, *22*, 463–465.

Vol. XXVI, No. 6

ABSENCE OF HALF OF THE DIAPHRAGM*

(THORACIC STOMACH; DIAPHRAGMATIC HERNIA)

By EDWARD L. JENKINSON, M.D.
CHICAGO, ILLINOIS

LESIONS of the diaphragm, prior to the advent of the roentgen rays were not commonly identified before death. Small hernias were in most instances unsuspected. In many patients small hernias are of very little importance. We are of the opinion, however, that the early diagnosis and prompt adequate medical treatment of these cases, minimizes the possibility of the hernia becoming larger and causing symptoms. It has been our experience, in observing several patients with small hernias which have gone untreated, to see the hernia become larger and as it increases in size the symptoms become more pronounced.

Only a brief review of diaphragmatic hernia will be given in this paper, as the subject has been very thoroughly covered in excellent papers by LeWald, Morrison, Kirklin, and others.

We believe the most important factor in identifying small hernias is the careful roentgenoscopic examination, especially in the recumbent position. Many will be overlooked if the patient is examined only in the upright position. Repeated examinations are often necessary to identify the hernia. The use of a "tilt" table is also of great value in filming the hernia.

The larger hernias, as a rule, are identified very readily roentgenoscopically.

In our series most hernias have occurred on the left side through the esophageal opening. The excursions of the diaphragm are usually normal, even in the larger types. If the hernia is through the central tendon the movements may be limited or reversed, not always, however.

We have classified these lesions as congenital, having a sac with one or more of the component layers of the diaphragm as a covering; the acquired type, or evisceration due to an injury, having the serous coat of the stomach as a covering. These cases usually follow crushing injuries, stab or bullet wounds.

Thoracic stomach is not a common lesion and is entirely compatible with life. The case we wish to report was in an old man who was able to carry on his daily duties with no great amount of disability.

In the presence of thoracic stomach the diaphragm shows the normal number of openings and the excursions are equal and regular. From the roentgenoscopic findings the diaphragm shows nothing abnormal.

The stomach is located above the diaphragm at all times. The esophagus is usually short, due to the high position of the stomach. The stomach is in the vertical position and usually causes some displacement of the heart. In the case we are reporting the stomach was located in the left half of the chest. The pylorus pointed downward and was located above the esophageal opening of the diaphragm immediately to the left of the midline. Occasionally the pylorus may pass through the esophageal opening. The duodenum as a rule passes through the esophageal opening of the diaphragm. At no time have we found any of the other abdominal viscera in the thorax.

Thoracic stomach can be identified with less difficulty than hernia. The roentgenoscopic examination is usually conclusive; occasionally the exact opening through the diaphragm can be better outlined by means of films.

It is always well to do a complete gastrointestinal examination to determine definitely whether or not there is bowel in the thorax and to identify the stomach always in the thorax.

Six cases of thoracic stomach have been reported in the literature, two by LeWald, one by Roberts, one by Morris, one post-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

mortem case by Bailey and one by Lyons, and I wish to add one case discovered roentgenologically.

CASE REPORT

Male, colored, aged sixty-eight. Family history of no importance. Admitted to the hospital complaining of loss of weight and burning in the chest for past six months; gastric distress for past thirty-five years.

Past History. In 1893 patient had his first gastric distress (thirty-two years of age). This distress continued for one year, during which time the patient could not eat more than a cupful at a time. He lived on bread and water for three weeks and gradually improved and has been able to work up to the past year. According to the patient, he has "spit up fluid which should stay in his stomach." He has lost 40 pounds, which loss of weight has been accompanied by weakness.

Since 1893 he has felt as though food lodged in his throat. It is quite a common practice for him to vomit a full meal. By "stuffing," as he puts it, he can go several days without vomiting, but eventually he must vomit to relieve the feeling in his throat. Rochelle salts seem to force food down. Bowel movement once daily.

Physical Examination. Chest expansion good, bulging of left chest. Bronchial breathing over both lungs. Râles at bases posteriorly. Tympany along right sternal margin. Heart—no enlargement. No thrills. Systolic murmur at apex. Abdomen scaphoid—no tenderness, rigidity or spasm. Liver palpable; spleen not palpable. Ewald test: Free acid 20.0, combined 10.0. Total acidity 30.0. Urine, acid; sp. gr. 1.020; albumin; sugar; microscopic examination, negative. Blood pressure, 150/100. Stools negative for blood. Wassermann, 4 plus. Red blood count, 3,850,000; white blood count, 6,200; hemoglobin, 70 per cent.

The roentgen findings were as follows: The stomach is located in the thorax, posterior to the heart and extends slightly to the right. The esophagus is short, about 3 inches in length, and enters the cardiac portion of the stomach at the superior level of the sternoclavicular articulation. The greater curvature of the stomach points to the right and downward. The pylorus is pointing downward and to the left, and is regular in outline. The duodenal bulb is difficult to visualize but at times appears quite regular and is located apparently at about the normal esophageal opening of the diaphragm. The diaphragm is intact on both sides. The stomach is empty at the end of five hours; most of the barium meal has reached the terminal ileum at the end of five hours. At the end of twenty-four hours the entire barium meal is well distributed throughout the large bowel, showing a normal motility. The colon fills readily, showing no filling defects or obstructions. The sigmoid is elongated and extends up to the midline of the abdomen and then turns to the left and is looped. The distal half of the large bowel is redundant and moderately dilated. The transverse colon is low but is freely movable. The ascending colon and cecum are regular in outline. The appendix is filled and points inward and then upward; movable and not tender.

The upper right chest is somewhat retracted. The diaphragm is regular on the left and shows an adhesion in the midportion on the right. The heart is increased in its transverse diameter. The aortic arch is rather prominent to the left. There is a definite widening of the mediastinal structures, both to the left and right, especially the right, which seems to be independent of the thoracic stomach and may be due to a mediastinal growth. The interlobar pleura on the right is definitely thickened. Both apices are atelectatic and the right shows definite evidence of pathology. There is a diffuse thickening throughout both lung fields due to scarring and also possibly to some compression.

Congenital absence of diaphragm, left side, was described by Harris and Clayton-Greene in 1912. Since this time 10 cases have been reported. LeWald has done extensive work on lesions of the diaphragm. In an article in 1927, he reports 4 cases, giving roentgen and clinical findings, with excellent illustrations.

Lesions of the diaphragm are very interesting and are often hard to differentiate. No doubt cases of absence of the left side of the diaphragm have been diagnosed as diaphragmatic hernia. The differentiation of these two lesions is important from the surgical standpoint. It is important that the surgeon know definitely whether there is

only a hernia or a complete absence of one side of the diaphragm.

If there is an absence of half of the diaphragm, it will be impossible for the surgeon to accomplish much, therefore an accurate diagnosis will save the patient a useless operation. A case reported by Clayton-Greene demonstrates this point in a mistaken diagnosis.

The diaphragm is not essential to life. Complete absence of the diaphragm is normal in animals below mammals. As has been shown by Colton, absence of the left diaphragm is not uncommon in dogs.

LeWald reports one patient with absence of the left half of the diaphragm who was a successful five mile relay runner. The 4 cases reported by Le Wald were thirty-one, sixty-two, thirty-seven and forty-seven years of age.

On reviewing the literature we were able to find 11 cases reported, one by Harris and Clayton-Greene in 1912, 4 by LeWald, 4 by Keith (3 fetal and one seventy years of age) one case by Klebs, with total absence of the diaphragm who lived six years, one case in a new-born by Meyer. We wish to add 3 cases, 2 fetal and one six years of age. One case showed an absence of the right half of the diaphragm.

Both roentgenoscopic and roentgenographic examinations are of great value and are necessary to complete the study. It is essential that a lateral study be made, for in this position both domes of the diaphragm can be seen when present. Occasionally absence of the left side of the diaphragm is confused with eventration. In eventration the diaphragm may be unusually high and thin, but it can be identified if studied carefully. Occasionally the dome-shaped wall of the pars cardia of the stomach may be mistaken for the diaphragm. Roentgenoscopically this can be differentiated as there will be no excursions of the shadow if due to the stomach.

The three patients we have seen complained or showed signs of respiratory embarrassment. They were sent to the roentgen department for chest studies. Two of the patients were two days old. Roentgen examination showed the left chest of Case 1 filled with bowel, greatly dilated.

The right diaphragm was normal but the left diaphragm could not be demonstrated roentgenographically or roentgenoscopically. The patient lived only a few days. The post-mortem examination revealed an absence of the left half of the diaphragm. The small bowel and a portion of the large bowel were located in the thorax.

The second case, a negro new-born, was sent to the department for a study of the chest. The roentgenogram showed the right chest filled with bowel. The right diaphragm could not be seen. The left diaphragm was normal. The patient died shortly afterward and the autopsy revealed an absence of the right half of the diaphragm. The thorax contained small bowel and a portion of the large bowel. The stomach was displaced downward and to the left. The liver filled the upper half of the abdomen. The left diaphragm was intact.

The third case, a girl six years of age, was sent to the department for a chest study with special reference to a foreign body. The film showed the left chest obliterated. The shadow was rather peculiar, and we asked for a roentgenoscopic examination of the chest and gastrointestinal tract.

On roentgenoscopic examination the fluid could be moved and a definite fluid level obtained. The diaphragm on the left was absent. With the patient upright, areas characteristic of bowel were seen in the left chest. The patient was given a barium meal and the fluid in the left chest was found to be in the stomach. The esophagus extended downward, practically normal in length. The stomach was located in the chest. There was a marked residue due to an acute angle in the second part of the duodenum. A barium enema revealed the splenic flexure in the thorax.

The patient was operated upon, but died on the table. The diaphragm was absent on the left.

SUMMARY

1. Congenital absence of the diaphragm, an uncommon condition, usually occurs on the left side but may be on the right. The condition should not be confused with diaphragmatic hernia or thoracic stomach.

2. Thoracic stomach, a rare condition, does not necessarily shorten life and is comparatively easy to diagnose roentgenoscopically. The roentgenologist should be sure that the stomach and the stomach only is located in the thorax.

3. Diaphragmatic hernia should be definitely differentiated from absence of one-half of the diaphragm. The surgeon is in need of such information if he is to do his patient the most good.

REFERENCES

1. BAILEY, P. *Anat. Rec.* 1923, *17*, 107–109.
2. COLTON, B. P. Zoology. D. C. Heath & Co., Boston, 1909, p. 283.
3. FINEMAN, S., and CONNER, H. M. Right diaphragmatic hernia of the short esophagus type. *Am. J. M. Sc.*, 1924, *167*, 672–679.
4. GREENWALD, H. M., and STEINER, M. Diaphragmatic hernia in infancy and childhood. *Am. J. Dis. Child.*, 1929, *38*, 361–392.
5. HARRIS, W., and CLAYTON-GREENE, W. Congenital absence of the left half of the diaphragm, simulating pneumothorax. *Proc. Roy. Soc. Med.*, 1911–12, *Clin. Sect.*, *5*, 153–156.
6. HUME, J. B. Congenital diaphragmatic hernia. *Brit. J. Surg.*, 1922, *10*, 207–215.
7. KEITH, ARTHUR. Diaphragmatic herniae. *Brit. M. J.*, 1910, *2*, 1297.
8. KLEBS. In Eppinger. Allgemeine und spezielle Pathologie des Zwerchfells. Suppl. zu. H. Nothnagel. Spezielle Pathologie u. Therapie.
9. LEWALD, L. T. Thoracic stomach. *Radiology*, 1924, *3*, 91–104.
10. LEWALD, L. T. Congenital absence of left half of the diaphragm. *Arch. Surg.*, 1927, *14*, 332–344.
11. LEWALD, L. T. Roentgenological diagnosis of diaphragmatic hernia. AM. J. ROENTGENOL. & RAD. THERAPY, 1928, *20*, 323–330.
12. LYONS, C. G. Thoracic stomach. AM. J. ROENTGENOL. & RAD. THERAPY, 1930, *23*, 67–69.
13. MEYER, A. W. Spolia anatomica. *J. Anat. & Physiol.*, 1914, *48*, 107–173.

DISCUSSION

DR. B. R. KIRKLIN, Rochester, Minn. I wish to congratulate Dr. Jenkinson on his very excellent paper. It is very important that the correct diagnosis be made in lesions of the diaphragm in view of the fact that the surgeon will have to rely almost solely upon the roentgenologic diagnosis. As Dr. Jenkinson has stated, it is sometimes rather difficult to differentiate between the three lesions: thoracic stomach, diaphragmatic hernia and eventration.

At the Mayo Clinic we have found that the diaphragmatic hernias are most easily demonstrated with the patient lying on his back and occasionally in the Trendelenburg position. He is then examined after a full inspiration. The stomach can be seen to protrude through the hernia opening in the diaphragm. It is most important, when such a lesion is suspected and is not recognized in the first examination, to make repeated examinations. One will frequently be rewarded by finding a small hernia which could not be seen at previous examinations. Harrington states that the small hernias which are difficult to recognize roentgenologically frequently produce more symptoms than the larger ones.

DR. LEON T. LEWALD, New York City. It has been a satisfaction to me to have Dr. Jenkinson confirm some of these conditions which I had reported some time ago. There was a very skeptical roentgenologist present who, when I showed my cases of congenital absence of the diaphragm, said, "There is no such thing." I wouldn't have felt so definite about it myself if I had not seen the specimen from the case of Greene's in the Museum at St. Bartholomew's Hospital in London. That case, by the way, taught a lesson which I think Dr. Jenkinson wishes to emphasize, and that is if you can be sure there is such a complete absence of one-half of the diaphragm, where is the surgeon going to get anything from which to make a new diaphragm? So that if you are absolutely sure of this, limit any operative intervention to some complication that might occur. One case was reported in which the appendix was actually inflamed and had to be removed *from the chest cavity*, and other cases have been reported in which there has been intestinal obstruction from twisting of the very loose bowel, requiring operative intervention.

The "thoracic stomach" comes in that same category and does not require surgical intervention *unless some complication occurs*. Roentgenographing the patient in a completely inverted position may demonstrate the diaphragm more clearly.

In congenital absence of half the diaphragm the position of the stomach may be very low. In another case of complete absence of left half of the diaphragm the stomach showed a peculiar inverted position.

In regard to eventration, or high diaphragm, Dr. Morison, of London, at one time classified this condition as hernia. But I consider it better to make it a separate condition. In regard to true diaphragmatic hernia through a false opening in the diaphragm or through one of the natural openings, I was called upon as the third roentgenologist to decide whether there was a hernia present or not. One roentgenologist had seen the stomach partly in the chest cavity, while another roentgenologist had not, and I was fortunate enough at the time I examined the patient to demonstrate some of the stomach in the chest cavity. If we classified the high diaphragm as eventration and not hernia, then we have four different conditions to discuss, namely, true diaphragmatic hernia, hernia through the esophageal orifice, thoracic stomach, and eventration of the diaphragm.

Dr. David R. Bowen, Philadelphia. I have had at least one experience which shows that these conditions are not incompatible with a very high degree of comfort and physical efficiency. An Italian woman in her early thirties came to me about five years ago from the medical ward as recovering from pneumonia, and having transposition of the heart. I made a diagnosis from stereoscopic films of eventration, because I could find no trace of the left diaphragm. She emphatically refused roentgenoscopy for confirmation. About three weeks ago the same woman was referred from a maternity ward with the same diagnosis. The maternity department had referred her without knowing of the previous study. When she saw where she was, she refused to have any further examination of any kind. She is a multipara, had a normal delivery and was making normal recovery. Of course, that is not absolutely confirmed, because I had no fluoroscopic examination, but the level of the stomach, the fundus of the stomach was above any part of the heart, about the level of the arch of the aorta, and there was a complete right-sided position of the heart on account of the invasion of the left thorax.

Dr. L. R. Sante, St. Louis, Mo. I just want to call attention to one rather unusual complication that occurred in our experience in connection with thoracic stomach. A middle aged woman entered the hospital with a history of having had an acute pain in the left side of the chest and upper abdomen. This soon subsided so that when she was admitted to the hospital some twenty-four hours afterwards, she was not in unusual distress. In fact, she was comfortable enough so that she was able to stand in front of the fluoroscope for examination. A large pouch was noted in the left lower portion of the chest with a distinct fluid level. With the patient in the horizontal position, this fluid level extended well down beneath the diaphragm into the pelvic region. At first it was thought that we were really dealing with spontaneous pneumoperitoneum from rupture of a hollow viscus. On close examination air was seen on both sides of a flail diaphragm which showed a large opening with some structure running through it. She developed infection within the next few days and died forty-eight hours afterwards. It was found at autopsy that she was suffering from a ruptured gastric ulcer in a thoracic stomach.

Dr. Jenkinson (closing). I appreciate the very generous discussion. We have two more cases of what we believe to be absence of the diaphragm. One of them we have had since this paper was written, proved at autopsy, but I did not have time to get it in this report. Another case, an adult, was injured last week and has multiple fractures of the pelvis. The roentgenogram of his chest reveals bowel above the diaphragm. We haven't had a chance, due to the fact he was severely injured, to determine whether he has an absence of the diaphragm, an eventration, a hernia or an evisceration due to his injury. I think from an operative standpoint these cases of congenital absence are important. The last case I showed, the child of six with the stomach and bowel up in the chest, with the fluid level, was sent in from the country and had had a rib resection. This was a mistaken diagnosis as the fluid was in the stomach and not free in the pleural cavity. Therefore, I think it is important that these patients be thoroughly investigated before an opinion is given.

AN EFFECTIVE GALL-BLADDER STIMULANT TO SUPPLANT THE FAT MEAL

By LESTER LEVYN, M.D.
BUFFALO, NEW YORK

CHOLECYSTOGRAPHY is employed by most roentgenologists as a routine procedure in gastrointestinal examinations. Boyden demonstrated the action of fats in stimulating gall-bladder contraction in animals. Sosman, Whitaker and Edson, in a series of interesting experiments, showed that the ingestion of fats resulted in the disappearance of the cholecystographic shadow in humans. Reduction in size of the gall-bladder occurs in from five minutes to one hour after the fat meal, while the shadow disappears entirely in three to six hours.

It is a common practice to give a fat meal in the course of the cholecystography and to begin the barium meal series from one to three hours subsequent to the fat meal. We have repeatedly observed that when such a technique is employed six-hour gastric residue of varying amounts results, the fats greatly retarding gastric motility. Obviously in the presence of lesions in the stomach and duodenum uncertainty might ensue as to whether gastric residue is due to organic changes or to physiological delay normally induced by the action of fats. This can be obviated if the barium meal examination is not begun until the day following the cholecystographic study.

For economic reasons, however, it is important to complete the combined examinations within as short a period of time as is consistent with thoroughness. We have endeavored to find a substitute to supplant the fat meal generally employed; a substance that would be an equally effective gall-bladder stimulant and one that would leave the stomach rapidly. Experiments were conducted to determine the effects of the various ingredients of egg yolk, the detailed work of which will be published at a later date.

The purpose of this communication is to record a modified method of administering the fats. The egg yolk ingredient which produced the most adequate and prompt contraction of the gall-bladder was lecithin.

Lecithin is composed of the esters of oleic, stearic, palmitic and other fatty acids with glycerophosphoric combined with choline. Taken internally, it is in part broken up by the fat splitting ferments of the pancreas into its constituent parts, but absorbed partially unchanged. Its absorption unchanged apparently depends upon the presence of bile in the intestines. Lecithin is a yellowish brown, waxy solid of a peculiar odor. It is soluble in equal parts of cold absolute alcohol and readily soluble in chloroform, ether, benzine and fixed oils.

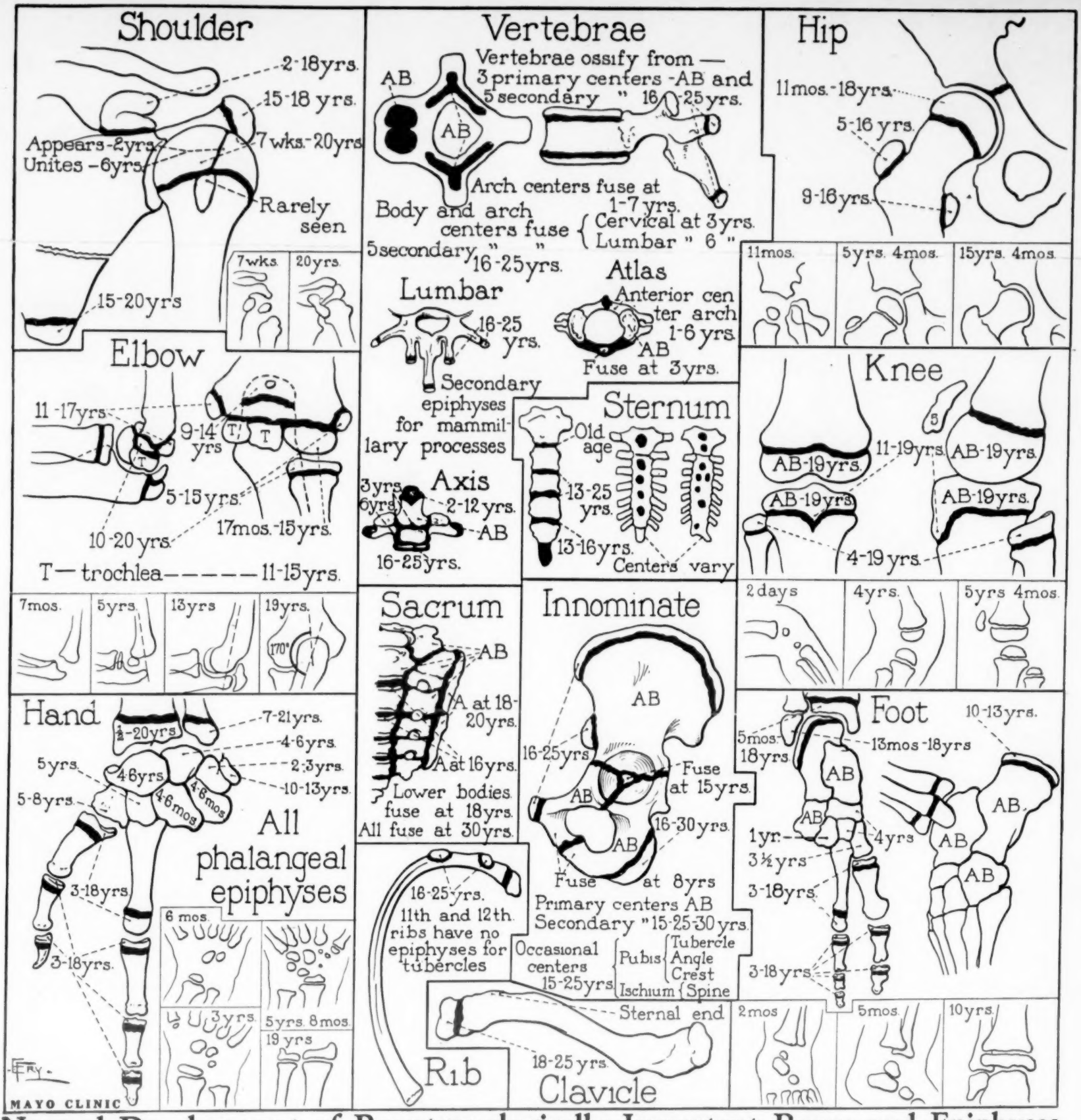
We believe that lecithin if not the specific agent is the most active ingredient of egg yolk that induces gall-bladder contraction. Under the name of Glyconin there is used for medicinal purposes in France, an emulsion of egg yolk and glycerin. The emulsion is very smooth, does not separate and may be preserved indefinitely. This preparation has been found by us to diminish the size of the gall-bladder. The addition of lecithin greatly augments its action. It is prepared in the following manner: the yolk of one fresh egg (45 gm.) is rubbed in a mortar; to this is slowly added 55 gm. of glycerin until thoroughly mixed; 2.5 gm. of lecithin is next disolved in 3 c. c. cold absolute alcohol. This is then added to the egg yolk and glycerin, again thoroughly mixed and strained. The total is approximately 100 gm. The emulsion can then be placed in a bottle or other container and keeps indefinitely. It possesses the following advantages over the ordinary fat meal of egg yolk and cream generally employed:

1. A small dose (10 c.c.) is as effective in stimulating gall-bladder contraction as the larger fat meal, *and does not retard gastric peristalsis.*

2. It leaves the stomach rapidly and the barium meal examination may be instituted immediately at the conclusion of the cholecystographic study.

3. It overcomes the aversion of many patients to eggs and cream.

4. It provides a standardized method of administering a gall-bladder stimulant in lieu of the many varieties of fat meals now used.



Normal Development of Roentgenologically Important Bones and Epiphyses

JOHN D. CAMP, M. D. AND EARL I. L. CILLEY, M. D.

1. A = Appears. U = Unites.
2. The number on a tarsal or carpal bone indicates the age at which calcification is roentgenologically visible.
3. AB - Ossification visible at birth.
4. Two numbers, i.e. 16 – 25 indicate visible ossification at 16 yrs. and union at 25 yrs.
5. The number at a cartilaginous junction indicates age at which ossification occurs.
6. There is considerable normal variation at any given age

Vol. XXVI, No. 6

DIAGRAMMATIC CHART SHOWING TIME OF APPEARANCE OF THE VARIOUS CENTERS OF OSSIFICATION AND PERIOD OF UNION

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THE accompanying chart was devised by us several months ago for use in the Section on Roentgenology of The Mayo Clinic. It represents an attempt to present for roentgenologists, the essential data pertaining to the time of appearance of the various centers of ossification and the time of their union. The chart has been a convenient source of reference in our routine work and frequent requests for copies have prompted us to publish it for the benefit of those interested. Many of the drawings have been copied, with certain modifications, from standard anatomy texts and other references pertaining to the subject. The appended information has been compiled from the same sources.

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EDITORIAL

PROGRESS IN THE ROENTGENOLOGIC EXAMINATION OF THE ALIMENTARY CANAL

TO ROENTGENOLOGISTS who witnessed the marvelous development of roentgenologic examination of the alimentary canal during the decade from 1910 to 1920, its advance since that time has seemed slow and devoid of striking features. In that decade, roentgenologic study of the digestive tract rapidly became one of the most useful and most spectacular applications of the roentgen rays to medical diagnosis. Indeed, its achievements came so suddenly that it seemed to be wholly new, and the tedious steps which preceded it were all but forgotten. Nevertheless, as early as 1898 Cannon had employed a bismuth salt in study of the alimentary tube of animals, and a year later Williams and Cannon applied the method to examination of the stomach of man. However, its capabilities were evidently not fully appreciated, for the lull which followed was scarcely broken until 1906, when Hemmeter tried more or less successfully to exhibit the crater of a gastric ulcer by adherence to it of a fleck of bismuth. The lead in research then passed to the other side of the Atlantic. In 1909, Reiche definitely demonstrated the crater of an ulcer on the lesser curvature after filling the stomach with a suspension of bismuth. Then Holzknecht, ably assisted by his distinguished colleague, Haudek, developed an efficient roentgenoscopic technique. Arnsperger, Faulhaber, Haenisch, Schwarz, and other continental roentgenologists plunged zealously into the work, and Barclay forwarded it in England. Diagnostic success was immediate and remarkable, and the rejuvenated method came back to America, where the Snook interrupterless transformer and the Coolidge tube gave it tremendous impetus. Cole established the diagnosis of duodenal ulcer on a firm and empirical foundation, Case contributed substantially to roentgenology of the colon, and Carman applied Holzknecht's screen technique with conspicuous excellence, taught it to his pupils, and perhaps more than any other man popularized the method in this country. A slight retardation was caused by the World War, but by 1920 technique and interpretation were fairly standardized and widely employed.

In the years that have followed, it is difficult to find any novel or basic improvement of the art. It may be that the procedure has become unduly standardized and static, or that peripheral growth continues unabated but is not obvious because the circle of knowledge was already widened so vastly, or that significant developments are being overlooked as they were prior to 1910. Inevitably, opinions will differ in choosing among these explanations, and estimates of the relative importance of current modifications and tendencies will likewise differ. One notable trend abroad is that toward more thorough study of the internal relief of the alimentary tube as exemplified in the work of Forssell, Fischer, Åkerlund, Berg and others. In principle the method depends on the use of opaque mediums in amounts just sufficient to coat the mucosa and thus exhibit the internal topography of the viscus. For example, to examine the stomach Berg administers a few swallows of an aqueous suspension of barium, distributes it over the internal wall by manipulation or by the use of a distinctor, thoroughly inspects the mucosal surface, and, if abnormal conditions are found, substitutes a film-holder for the screen and makes roentgenograms at favorable angles of view. In his monograph Berg expressly disclaims any novelty for the procedure. He

points out that Holzknecht's long-established technique provides for inspection of the gastric internal relief before the stomach is filled, and he gives full credit to the researches on the gastric rugae by Forssell, whose work began in 1913. He also cites Fischer's improved method for examining the colon by which the opaque enema is largely evacuated to permit observation of the thinly coated wall of the bowel. Incidentally, it may be noted that recently Weber has advantageously elaborated Fischer's technique by inflating the bowel after evacuation and then making stereoscopic roentgenograms.

Carman, who adhered closely to the Holzknecht technique, insisted strongly that roentgenoscopic examination of the stomach must begin when the first swallow of barium is taken, and that the medium must be distributed over the gastric wall by palpatory manipulation in order to allow study of the mucosal relief and to reveal small tumefactions or niches en face. His pupils and successors, as well as many others, have consistently practised this detail. The additional employment of roentgenography by Berg and others is valuable for purposes of record, and for the instruction of students. It has been urged, also, that roentgenograms furnish objective proof of a diagnosis to the clinician and surgeon, but this argument will not receive universal endorsement, for it can logically be contended that inasmuch as the pathologist and bacteriologist are not required to submit microscopic slides in evidence of their opinion, similar confirmation should not be demanded from the roentgenologist.

Conceding Berg's disclaimer of originality, his work, together with that of Forssell and Fischer, is nevertheless progressive and indicates a definite trend toward more critical investigation of the mucosal relief in the search for signs of disease which may otherwise escape discovery or exact diagnosis. The interest aroused by this work suggests also that roentgenologists have sometimes neglected to apply its principle. Certain is it that gross disease is often demonstrable by filling the canal with the opaque medium, and complete distention at some time during the examination is desirable or necessary, but filling and distention alone are not adequate. Aside from its practical value, the work is a token that the ardor for research has not vanished, and that in due time roentgenology of the digestive tract will make the further progress of which it is capable.

B. R. Kirklin

Vol. XXVI, No. 6

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Thirty-third annual meeting: Detroit, Mich., 1932.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: New Orleans, La., 1932.

Section on Radiology, American Medical Association
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: New Orleans, La., May 9–13, 1932.

Radiological Society of North America
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Seventeenth annual session: Hotel Jefferson, St. Louis, Mo., Nov. 30–Dec. 4, 1931.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. John F. Chapman, 209 Professional Bldg., Pasadena Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401–76th St., Brooklyn, N. Y.
Meets monthly on the first Tuesday from October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
Secretary, Dr. A Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Illinois Radiological Society
Secretary, Dr. Fauntleroy Flinn, 220 South Webster St., Decatur, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting: Rochester, Minn., October, 1931.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. Robert C. Hall, 258 Genesee St., Utica, N. Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, to be announced.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary-Treasurer, Dr. E. W. Spinzig, 316 Metropolitan Bldg.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburgh, Va.
Next meeting, to be announced.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD-UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

X-RAY PROTECTION

In these busy times roentgenologists are apt to overlook some of the dangers to themselves, their assistants and their patients. Moreover, there are certain hazards with which many of us may not be familiar. For many years the American Roentgen Ray Society has had a Standing Committee on Safety which has functioned in an advisory capacity. Unfortunately the reports of this Committee have never been given much prominence nor have they been readily available.

Following the International Congress in 1928, an Advisory Committee on X-ray and Radium Protection was formed in this country, composed of two members each from the American Roentgen Ray Society, the Radiological Society of North America, the American Medical Association and the manufacturers of x-ray equipment. The chairman has been Dr. Lauriston S. Taylor, of the United States Bureau of Standards and representing the International Safety Committee and the National Bureau of Standards.

This Committee has completed all of its work with the exception of that pertaining to radium protection. The report has been published as Handbook No. 15, Bureau of Standards. It contains recommendations for x-ray and electrical protection, regulations for x-ray equipment in anesthetic rooms and for the storage of films and general operating rules.

This report of the Committee was reprinted from Handbook No. 15 in the September number of the *American Journal of Roentgenology and Radium Therapy*. It was thought advisable by the Editor of the Journal and by the Committee on Safety and Standards of the American Roentgen Ray Society to have reprints made from the report in the Journal so that they may be available to those who wish them. The report is extremely valuable and should be in the hands of all those practising roentgenology and accessible to everyone connected with such departments. Copies will be mailed to every member of the American Roentgen Ray Society and copies can be obtained by anyone on request to the Secretary, Dr. Eugene P. Pendergrass, University Hospital, Philadelphia, Pa.

Henry K. Pancoast, *Chairman*
Committee on Safety and Standards

ROENTGENOLOGICAL CONFERENCE

The New York Roentgen Society invites all those interested to join with the New England Roentgen Society, the Philadelphia Roentgen Ray Society and the roentgenologists of Baltimore and Washington in a Roentgenological Conference to be held in New York City on Friday and Saturday, January 29 and 30, 1932. The headquarters will be the Hotel Pennsylvania. The Secretary of the New York Roentgen Society, Dr. J. Bennett Edwards, 144 Woodridge Place, Leonia, N. J., may be consulted for further details.

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, 105 Rutledge Ave., Charleston, S. C.

A SIMPLE TECHNIQUE FOR INTRAVENOUS CHOLECYSTOGRAPHY

By JACOB H. VASTINE, M.D.
PHILADELPHIA, PENNSYLVANIA

THE oral and the intravenous method of administration of dye for visualization of the gall-bladder each has its staunch advocates. The various advantages

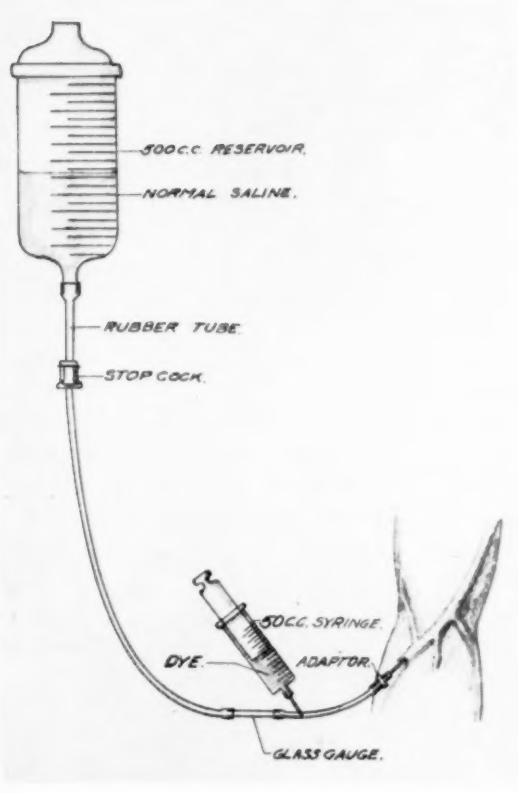

FIG. 1

of the intravenous method are so well known by most roentgenologists that they need not be repeated here. The chief disadvantages so frequently cited are the involved and time-consuming nature of the introduction and the possibility of sore arm (phlebitis or cellulitis). It is our belief that by using a relatively large needle and introducing the dye quite rapidly there is less chance of local reaction. This is contrary to the usual opinion in regard to rapidity of introduction. However, a too rapid introduction causes an immediate flushing of the skin, palpitation and occasional faintness so that the rate of introduction must be a happy medium. We have had no reaction with sodium phenoltetraiodophthalein (iso-iodeikon). Graham, Waters, and others report the iso-iodeikon to be less irritating and to be attended by less reaction.

By the use of the less irritating salt, by careful regard to the rate of introduction and by administration of the dye in at least 125 c.c. of normal saline, the probability of either local or constitutional reaction is inconsiderable, particularly when compared to the reactions sometimes accompanying the oral administration of the dye.

The other main objection frequently raised to the routine employment of the intravenous method is the involved and time-consuming nature of administration. The accompanying diagram (Fig. 1) shows the simple set-up which we have employed for the administration of the dye in over 400 cases. This has been used in hospitalized and ambulatory patients with complete satisfaction, and only minor changes have been made in several years. Not more than ten minutes is necessary from the time the patient is placed on the table until the injection is completed.

We believe that the simplicity of this set-up completely obviates the principal objection to routine employment of the intravenous method. This is a modification of Liest's method. It is simpler than that of Liest, and it permits a shortening of the

time required for the injection due to the shorter length of tube from the arm to the point of injection of the dye.

Several sterile trays are always kept ready containing the following equipment: 500 c.c. burette; rubber tube containing glass gauge about 6 inches from distal end; a stop cock and needle adaptor in distal end of rubber tube; two No. 19 gauge needles; a 50 c.c. syringe; three beakers, in one of which is placed about 50 c.c. of normal saline and in another some alcohol; several thicknesses of sterile gauze; sterile pledgets of cotton; a stirring rod; and a file for opening the ampule. The dye is dissolved in the sterile normal saline, strained through several layers of sterile gauze and drawn into the 50 c.c. syringe and one No. 19 gauge needle placed on the syringe. The other No. 19 gauge needle is then introduced into the vein and the tube with adaptor is attached. Twenty-five cubic centimeters of normal saline are permitted to flow into the vein before injection of the dye into the tube is begun, to be certain that there is no leakage about the needle into the tissues about the vein. The dye is then injected into the rubber tube distal to the gauge and while the dye is being injected, 75 c.c. of normal saline flows from the reservoir carrying the dye into the vein. This makes about 125 c.c. of normal saline in which the dye is introduced. The rate of injection is governed so that the upper limit of the dye is in the glass gauge.

Following injection of the dye into the tube and after withdrawing the needle from the rubber tube, 25 c.c. of saline continues to flow from the reservoir into the vein and washes the dye from the short tube and the needle, and the administration is complete.

Patients are instructed to take a fat rich meal several hours before the administration of the dye. They come in about 4 P.M. and receive the injection and are immediately permitted to leave and carry on their usual activities except that they are not permitted to take anything by mouth except water until after examination the following morning. The films taken during the course of concentration of the dye in the gall-bladder we do not consider informative. If the shadow is dense sixteen hours after administration, concentration has occurred; if it is faint, concentration has not occurred. Intermediate films, we believe, are a waste of both time and material. Films taken forty-five minutes after a fat rich meal are very valuable since at that time the shadow is about one-fourth its former size, and small, faint, negative calculi can sometimes be apprehended which were missed in the larger shadow. The rate of response to food is an important physiological activity which is diminished by intramural infections before the concentrating function of the mucosa is noticeably impaired. The diminished response to food according to Whitaker is an important factor in the formation of gallstones. This examination forty-five minutes after the fat rich meal, we feel is a most important observation which is frequently omitted by roentgenologists or not made until the gall-bladder is completely empty. Films at inspiration and expiration, as suggested by Pillmore, are made at both examinations.*

* A technique somewhat similar to this was described in a pamphlet distributed by Mallinckrodt, since this article was submitted for publication.

REFERENCES

1. Graham, E. A., Cole, Warren H., Copher, G. H., and Moore, Sherwood. Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928.
2. Liest, L. J. Technic for intravenous infusion of sodium tetraiodophenolphthalein in cholecystography. *Radiology*, 1926, *6*, 300–302.
3. Pillmore, G. U. Technique of gall-bladder examinations. Am. J. Roentgenol. & Rad. Therapy, 1928, *20*, 539–544.
4. Waters, Charles A., and Firor, W. B. Further studies in the application of intravenous cholecystography and liver function determination as employed in office practice. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 590–594.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

NUVOLI, UMBERTO: Roentgenographic anatomy of the skull 914

MONTANARI, ARRIGO: Tumors of the base of the skull 914

COURVILLE, CYRIL B., and ADELSTEIN, LEO J.: Intracranial calcification, with particular reference to that occurring in the gliomas. 915

LURIE, WILLIAM A.: Evaluation of dental roentgenographic shadows 915

Neck and Chest

SCHALL, L., and HOFFMANN, F.: The anatomy of interlobar fissures 915

SCHNEIDER, LEO V.: Primary aspergillosis of the lungs 916

SINGER, J. J., and BALLON, HARRY C.: Streptothricosis 916

WARNER, W. P.: Localized pneumothoraces as a cause of annular shadows in roentgenograms of the chest 916

JACOBOEUS, H. C., and WESTERMARK, N.: A further study of massive collapse of the lung 916

PORTA, REMO: Carcinoma of the lung with multiple cavities of the bronchiectatic type ... 917

FORBES, ROY P., VERPLOEG, RALPH, and BAZEMORE, M. K.: A survey of tuberculosis in schools in Colorado 917

WILCOX, HERBERT B., and WOLLSTEIN, MARTHA: Mediastinal teratoma in an infant ... 918

SUTTON, LUCY P.: Pericarditis with effusion ... 918

KIRKLAND, A. STANLEY: The thymus 919

ROFFO, A. H., and LOPEZ, RAMIREZ R.: Pharmaco-dynamic modifications of the normal and neoplastic esophagus 919

JUNG, T-SHAN, and VAN ALLEN, C. M. A method of recording respiratory movements on a single roentgenogram 920

Abdomen

ACKMAN, F. D.: Multiple adenopapillomata of the stomach with report of case showing varying degrees of malignancy 920

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

NUVOLI, UMBERTO. Anatomia radiografica del cranio. (Roentgenographic anatomy of the skull.) *Atti del IX Cong. Italiano di Radiol. Med.* Part I. Torino, 1930, pp. 1–26.

The article is divided into two parts: in the first the method of examination, in the second the anatomic appearance of the skull in the various positions being discussed.

Until a short time ago the author employed three fundamental positions: (1) the sagittal (fronto-occipital and less frequently, occipito-frontal); (2) the lateral (left-right and right-left), and (3) the axial (submento-bregmatic). Recently two other projections were added: the so-called oblique projections according to Stenvers or according to a modification of Busi. All roentgenograms are made with the aid of a Potter-Bucky diaphragm, the focus-film distance varying between 70 and 80 cm. Stereoroentgenograms are of the greatest importance.

In specially indicated cases one may use the following additional projections: (1) the occipito-frontal projection as already mentioned above, this being of particular value in the examination of the mastoids; (2) the projections for the visualization of the foramen opticum and petrous bone (MacMillan; Rhese-Balli; Goalwin), and (3) the supraorbital-occipito-frontal projection for the visualization of the dorsum sellae (Hass-Valdini).

The procedure as well as the anatomic interpretation of the skull in these various positions is described in detail, the article being illustrated with numerous schematic drawings and some roentgenograms of the anatomic specimens of the skull.—*T. Leucutia.*

MONTANARI, ARRIGO. Tumori della base cranica; studio clinico radiologico. (Tumors of the skull; clinical-radiological study.) *Atti del IX Cong. Italiano di Radiol. Med.* Part I. Torino, 1930, pp. 27–140.

The roentgen signs of endocranial tumor are general or local. As a rule, they may be divided into four groups: (1) direct alterations pertain-

ing to the tumor (calcification within the tumor); (2) local alterations of the contiguous bones (erosions and calcified proliferations); (3) regional alterations of the adjacent bones (changes of the sella, sphenoid, petrous bone, foramina, etc.), and (4) alterations due to increased generalized intracranial pressure.

The roentgen signs of endocranial hypertension are: (1) prominent impressiones digitates and juga cerbebralia; (2) thinning of the bones leading in the young to the so-called basal lordosis (Bertolotti); (3) separation of sutures; (4) dilatation of the sulci of the pacchionian grooves and emissary veins; (5) occasional circumscribed hyperostosis in the region of the tumor (endothelioma, cyst, tuberculoma), and (6) dilatation of the orifices of the base of the skull (optic canal, internal auditory meatus, and foramina of the middle fossa).

The intracranial tumors of the skull may be roughly divided into three groups: (1) those of the anterior fossa (principally meningiomas); (2) those of the middle fossa (principally tumors of the hypophysis), and (3) those of the posterior fossa (principally neurinomas). The roentgen changes in all these groups are discussed in lengthy detail. The article includes 39 case reports (5 personal, 20 from the collection of Professor Bertolotti and 14 from Professor Busi), richly illustrated (with a total of 85 figures).—*T. Leucutia.*

Courville, Cyril B., and Adelstein, Leo J. Intracranial calcification, with particular reference to that occurring in the gliomas. *Arch. Surg.*, Nov., 1930, *21*, 801–828.

Calcification may be seen in the pineal body, choroid plexus, sclerosed vessels, falx cerebri, pacchionian bodies, abscesses, etc. Calcification occurs in almost every type of new growth and the authors state that it occurs more frequently in gliomas than any other tumor with the exception of the cranio-pharyngeal pouch cyst.

The deposition of calcium is a chemical rather than a histologic process. It is found in the walls of the blood vessels more frequently than in the tumor cells. It is of value in the localization of tumors. The calcification may be evenly or unevenly distributed throughout the tumor and the authors think that it is evidence of benignity. Twelve cases are reported. Of these, 2 had microscopical studies and were classified as follows: spongioblastomas, 5; astrocytomas, 3; ependymal glioma, 1; and medulloblastoma, 1. Bone formation was found in one glioma.—*E. P. Pendergrass.*

Lurie, William A. Evaluation of dental roentgenographic shadows. *Am. J. Surg.*, Sept., 1930, *9*, 552–555.

In this paper the author has classified the shadows seen in the dental roentgen film. He divides them according to the density of the parts visible, i.e., the soft tissues are graded 1, the bone parts are graded 2, with subdivisions 2A, for the cancellous bones in which the teeth are imbedded and 2B, for the shadow cast by the teeth and the bone cortex. A grade 3, is given to the filling material normally found within the tooth or root canal, or a replacement for a decayed portion of a tooth.

The use of this classification predisposes a knowledge of normal appearance of roentgenograms of this area and an interpretation depends primarily on experience.—*F. K. Alexander.*

NECK AND CHEST

Schall, L., and Hoffmann, F. Zur Anatomie der Interlobärspalten. (The anatomy of interlobar fissures.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1930, *42*, 714–729.

The authors used a special technique for the roentgen visualization of the anatomic relations of the interlobar fissures. This consisted in the placing of one or two layers of gauze impregnated with plaster-of-Paris into the fissures and the taking of roentgenograms after inflation of the lungs. In order to produce hardening of the tissues the cadaver was first injected with formalin through the femoral artery. Then a plaster-of-Paris model was made of the diaphragmatic dome. After the thorax was opened by a lateral incision along the axillary line the lung tissues were placed in a vertical position on the plaster model, the molds inserted into the interlobar fissures and the roentgenograms taken.

The article is richly illustrated with photographs of the molds showing the various sizes and configurations of the interlobar fissures, as well as with diagrams showing their relative arrangement within the chest.

The anatomic anomalies observed consisted of trilobulation of the left lung, accessory bilateral lobus posterior (Dévé), right-sided lobus accessorius inferior (Rectorzik), lobus venae-

azygos, etc. Of the pathologic processes, the lesions of the lungs (bronchopneumonia, etc.), heart (mitral, tricuspid insufficiency, etc.), and certain deformities of the throax (habitus asthenicus, rickets, kyphosis and especially scoliosis) affected chiefly the configuration of the interlobar fissures.—*T. Leucutia.*

SCHNEIDER, LEO V. Primary aspergillosis of the lungs. *Am. Rev. Tuberc.*, Sept., 1930, *22*, 267–270.

Aspergillus fumigatus is a microorganism which produces pulmonary lesions resembling those of fibroid tuberculosis. Clinically and roentgenologically the two diseases are similar. Diagnosis is difficult, particularly where aspergillus infection is secondary to another respiratory infection.

The disease is transmitted from pigeons and parrots, and is found in hair-combers who use rice flour to remove grease from the hair.

A case is reported which clinically resembled fibroid tuberculosis of the lungs. Intravenous injections of 20 c.c. of a 10 per cent solution of sodium iodide daily for six days gave immediate improvement.—*G. R. Miller.*

SINGER, J. J., and BALLON, HARRY C. Streptothricosis. *Am. Rev. Tuberc.*, Sept., 1930, *22*, 233–266.

A case of streptothricosis is reported in great detail. Clinically the symptoms were first those of nephritis, later, of bone disease, and finally, of a widespread involvement of the lungs, ribs and chest wall. Throughout the disease purpura persisted. Fever and a moderate leucocytosis were also present.

At autopsy practically every organ was infected. In the lungs tuberculosis was also present. Inasmuch as the streptothrix often has been reported in sputum along with tubercle bacilli it seems that a differential point between the pathogenic and nonpathogenic organisms is their effect upon guinea pigs. The organism in this case was recovered also in the gums and in pus from superficial abscesses.

Treatment consisted of potassium iodide by mouth. The abscesses were incised and drained. —*G. R. Miller.*

WARNER, W. P. Localized pneumothoraces as a cause of annular shadows in roentgenograms of the chest. *Am. Rev. Tuberc.*, Nov., 1930, *22*, 531–538.

The cause of annular shadows observed in roentgenograms of the chest of patients suffering from nontuberculous and tuberculous pulmonary infections has often been obscure. The term "annular shadows" was first used by Fishberg in 1917 in describing shadows which had a circular appearance, and he used this in differentiating between cavities and large pneumothoraces. Their significance has been variously interpreted since then as due to cavitation, localized pneumothoraces, thickened pleura, and blebs. Sampson, Heise and Brown found 12 per cent of cases in an analysis of 400 patients having pulmonary tuberculosis. They interpreted them as being due to small caseating areas rupturing into a pleural space and giving rise to localized pneumothoraces, many of which contained fluid. Since that time numerous authors have offered various opinions on the subject. Warner appears to be the first to report a case in which annular shadows markedly resembling those cast by cavities have been diagnosed as due to localized pneumothoraces, and their origin proved at necropsy. He reports a case of a woman aged forty-three who had pneumonia in the right upper lobe. She died suddenly from a hemorrhage into the brain. At the post mortem two interlobar sacs corresponding to the location of those seen on the roentgenogram were found. Two other ones were advanced as to their origin; (*a*) walled off true pneumothorax, (*b*) small opening into one dilated bronchus which allowed air to escape into the interlobar pleura and become encapsulated. The opening could not be demonstrated.

The author agrees with the quoted statement, "Annular shadows should be considered as cavities until diligent investigation proves that they are to be better interpreted some other way." The roentgen appearances often offer no definite evidence for or against its representing a cavity, or being due to another cause.—*E. P. Pendergrass.*

JACOBOEUS, H. C., and WESTERMARK, N. A further study of massive collapse of the lung. *Acta radiol.*, Dec. 31, 1930, *11*, 547–595.

This is a clinical and roentgen study of 16 cases of massive collapse of the lung profusely illustrated with roentgenograms. Among the acute cases they describe a case of hemoptysis and in connection with it they discuss the frequency of collapse of the lung in hemoptysis and the circumstances under which it occurs.

Among the 25 cases of hemoptysis that they have seen in three years collapse has occurred in 4, chiefly in cases in which extensive hemorrhages took place within a short time. In 2 cases the acute collapse was an independent condition in recurrent bronchitis. These cases resemble postoperative collapse.

Among the cases of chronic collapse one occurred in bronchostenosis and bronchiectasis of unknown etiology and with only slight symptoms of collapse. The authors have seen 3 cases of collapse of the lung in bronchiectasis. In 2 of these cases the patients had had chronic bronchiectasis for many years and the collapse developed as a complication of the original disease. In the third case there was first acute collapse of the lung followed by extensive bronchiectasis. In these cases the bronchiectasis grew rapidly worse. The author thinks this was due not only to the infection but also to the markedly increased negative intrapleural pressure, which in 2 of these cases reached −30 and −40 cm. water. They also found pronounced broncho-amphoric breathing over the collapsed areas. This they think was due to the fact that the larger bronchi were open and dilated while the distal branches were occluded by products of inflammation. In support of this opinion they cite the pathologico-anatomical findings and the results of roentgen and bronchoscopic examinations.

They also describe 5 cases of collapse of the lung in chronic pulmonary tuberculosis without hemoptysis. Contrary to what has been reported by other authors they found that the collapse had a bad effect on the development and enlargement of the cavities. In these cases too they think the greatly increased negative pressure was an important factor.

Five cases of lung tumor with partial collapse of the lobe are described. In all of them there was a free pleural exudate the localization of which was quite different from that of the ordinary free pleural exudate. The outline of the exudate was sharp and passed obliquely from within and above downward and outward. The authors think the altered pressure conditions caused by the collapse were the cause of this unusual localization of the exudate.—*Audrey G. Morgan.*

Porta, Remo. Carcinoma polmonare con cavita multiple a tipo bronchiectasico. (Carcinoma of the lung with multiple cavities of the bronchiectatic type.) *Radiol. med.*, Jan., 1931, *18*, 9–17.

A man aged sixty-seven came to the hospital complaining of pain at the base of the left lung and moderate dyspnea which he said he had had for only about ten days. He had a cough with more or less abundant mucopurulent expectoration streaked with blood; it was not fetid. His evening temperature was 38° to 38.5° C. The physical signs indicated encysted lung abscess. Roentgen examination showed an intense shadow in the lower left lung field; its outlines were distinct and convex outward. There was nothing special in the rest of the lung picture except somewhat increased distinctness of the lung design. After exploratory puncture and the aspiration of about 40 c.c. purulent liquid, 20 c.c. heavy iodized oil and the same amount of light iodized oil were introduced. The picture then showed multiple elongated cylindrical cavities within the outlines of the former shadow. They were oblique toward the base and outward and seemed to follow the course of the bronchi. On the basis of this picture a diagnosis of multiple cylindrical bronchiectases of the left base was made.

No treatment did any good and the patient died five months later with signs of chronic intoxication and cachexia. Autopsy showed primary adenocarcinoma of the lung. Clinically it would have been hard to make the correct diagnosis in this case but it might have been made roentgenologically if more attention had been paid to the shadow seen at first and the suppurative cavity form of carcinoma of the lung borne in mind. Kindberg says that in any form of suppuration of the lung in a patient past forty years of age carcinoma should be thought of. All the cavities in this case were in the tumor. There were no dilatations of the bronchi elsewhere in the lung.—*Audrey G. Morgan.*

Forbes, Roy P., Verploeg, Ralph, and Bazemore, M. K. A survey of tuberculosis in schools in Colorado. *Am. J. Dis. Child.*, Jan., 1931, *41*, 26–32.

At the suggestion of the Colorado Tuberculosis Association a survey of the cases of tuberculosis in the school was undertaken in the town of Aurora. This town was especially suitable for this purpose, it being the site of the Fitzsimons Government Hospital, the largest institution in the United States caring for patients with tuberculosis. A large proportion of

the population are "contacts," the economic status of most of the families is below that of families in the average American community, crowded housing conditions and inadequate food budgets are common, and the incidence of juvenile tuberculosis here could be expected to be as high or higher than that in any community in the United States.

The authors' summary of their study follows:

1. The statistics for the mortality and morbidity of tuberculosis in children today and ten years ago are not comparable.

2. The number and the size of positive reactions increase in children commensurate with contact and age, as noted by Dickey.

3. The incidence of tuberculous infection among children varies greatly in different parts of the country, and is influenced by climatic and other environmental factors.

4. A survey for tuberculosis in the school of a small community composed largely of health seekers, when contact with the disease is unusually great, showed 36.4 per cent of 283 children from four to fifteen years of age to be infected. This is only a moderate increase over the incidence noted in nontuberculous communities.

5. Roentgen studies of the 103 children giving positive reactions revealed childhood tuberculosis in 19 or 6.7 per cent of the whole group, the average for the country at large varying from 1 to 4 per cent.

6. No child with the adult or exudative type of tuberculosis was found.

7. Most of the children reacting positively and those having actual childhood tuberculosis were not born in Colorado.

8. Climatic factors in Colorado apparently exert a favorable influence in the protection of children against active infection.

9. In this study, the father was the source of the infection in 64.8 per cent of the children giving positive reactions, and the mother in only 12.6 per cent.

10. Symptoms of fatigue, undernutrition and a history of frequent colds are not reliable aids in the diagnosis of childhood tuberculosis.—*R. S. Bromer.*

WILCOX, HERBERT B., and WOLLSTEIN, MARTHA. Mediastinal teratoma in an infant. *Am. J. Dis. Child.*, Jan., 1931, *41*, 89–97.

Mediastinal tumors in young children are not common, and solid teratomas in the thoracic cavity are especially rare. The authors report a case of mediastinal teratoma in an infant aged six months. The roentgenogram of the patient's chest showed the right side of the chest to be occupied in its entirety by a mass of considerable density. Clinically the picture was that of an infant, well nourished and on superficial examination, normal, except for respiratory embarrassment, which existed for one week before death. The history was one of normality up to three months of age, when the symptoms of respiratory difficulty appeared, so mild however, as to cause no concern on the part of his attendants.

The autopsy revealed a solid teratoma, the rare type of neoplasm found in the anterior mediastinum, in which dermoid cysts and teratomas, either solid or cystic occur. The tumor contained elements from all three embryonal layers. From the ectoderm came the hairs, the sweat and the sebaceous glands and the nerve trunks; from the mesoderm came the connective tissue, cartilage, striped and unstriped muscle, myocardium and lymph nodes, and from the entoderm came the lining of the esophagus, stomach, colon, trachea and the liver.

The small number of these cases in young children, compared with those in young adults and older persons is striking, the proportion being roughly one in ten. The treatment can only be surgical.—*R. S. Bromer.*

SUTTON, LUCY P. Pericarditis with effusion. *Am. J. Dis. Child.*, Jan., 1931, *41*, 78–88.

The author's object in this paper is to call attention to the pulmonary signs associated with moderate and large pericardial effusions. Although twice previously described by other authors, it has not been generally recognized that the effusion itself is responsible for the production of striking physical signs in the lower chest posteriorly.

In considering pericardial effusion, two facts must be kept in mind: (1) Contrary to earlier teaching, the heart does not change its position materially in the presence of effusion. (2) An inflamed pericardial sac is distensible far beyond the capacity of a normal pericardium.

Because of the attachments of the great vessels, and the fact that the heart lies a little more to the left than to the right side of the chest, the left pouch of the pericardium becomes more distended with fluid than does the right. As it becomes more and more distended and filled, it

extends posteriorly below the hilus of the lung, pushing the lung upward and laterally, until the pericardium actually comes in contact with the posterior wall of the chest. Curschmann thought that the lung was pushed medially against the vertebral column, but Sutton agrees with Conner that it must be compressed laterally. The signs thus produced range from dullness to flatness on the left side of the chest from the angle of the scapula down. Over all or part of this area there is bronchial breathing, usually intense, with bronchophony or egophony. A similar but smaller area is often present on the right side of the chest. The bronchial voice and breathing are produced by the transmission of the sound directly from the bronchus through the pericardial fluid. When the fluid is just beginning to accumulate and the amount is still small, an area of slight dullness may be found just inside of the angle of the left scapula, with breath sounds which are harsh or faintly bronchial. Tactile fremitus persists or may be diminished. Frequently there are fine râles just above the area of dullness and bronchial breathing. The author has found that there is always an area of resonance, sometimes very small, between the dullness of the posterior side and that of the left border of the heart. In pericardial effusion this area is always round or square, and the outer margin falls off sharply, while in pleural effusion the upper limit of the signs is the classic Ellis line, which is lower at the spine than in the midscapular line, and which slopes off gradually toward the axilla. These signs disappear gradually with the absorption of the fluid, which is usually complete in from ten to fourteen days.

Eight cases were studied to demonstrate these signs. Illustrative roentgenograms and tracings are shown. The author believes that these signs developing in a child with rheumatic fibrinous pericarditis constitute in themselves evidence of the presence of pericardial effusion. If any doubt exists, fluoroscopy or a roentgenogram will clear it up. The posterior site for tapping the pericardium, thoracentesis in the seventh or eighth space posteriorly, is perfectly safe, and one is far more certain of reaching the fluid than in using points previously recommended. Sutton feels that one need have no hesitation in adopting this procedure either for diagnostic or therapeutic purposes. It appears possible that removal of some of the fluid may hasten absorption and thus lead to quicker recovery.—*R. S. Bromer.*

Kirkland, A. Stanley. The thymus. *Canad. M. Ass. J.*, Nov., 1930, *23*, 661–665.

Children with thymic symptoms may be divided into three age groups: first, those having difficulty in the first few hours of life. Atelectasis is frequently associated with the thymic enlargement. These respond well and quickly to irradiation. The second group comprises those in which the thymic enlargement is manifest in the early weeks of life. The characteristic crow, cyanosis and difficulty in nursing are the usual signs. Roentgen therapy is usually effective in obtaining rapid relief of symptoms. The third group are those cases in which the thymus persists to a later age and its only danger lies in susceptibility of the child to infection and sensitivity to anesthetics. The thymus is usually symptomless in this group of cases. In large clinics where the chests of children are routinely examined roentgenologically, 1.6 to 7.5 per cent are found to have large thymic shadows. The author calls attention to the variance between the severity of the symptoms and the size of the gland. He also calls attention to the frequency with which relief of symptoms is obtained following roentgen therapy with no appreciable change in the size of the gland.

The author protects the thyroid gland and parathyroid glands in treating these cases, but he does not think this is absolutely necessary. He has found the effect of roentgen rays to be increased by administration of calcium chloride orally in small doses. The number of necessary treatments has thus been reduced. The author believes in the desirability and efficacy of roentgen therapy in children with thymic disorders with frank clinical symptoms or in children in whom there is roentgen evidence of thymic enlargement (when surgery is contemplated), although the thymic enlargement is symptomless. —*J. H. Vastine.*

Roffo, A. H., and Lopez, Ramirez R. Modificaciones fármacodinámicas en el esófago normal y neoplásico. (Pharmacodynamic modifications of the normal and neoplastic esophagus.) *Bol. Inst. de med. exper.* (*etc.*), Buenos Aires, 1930, *7*, 11–21.

The authors studied the motility of the esophagus by means of esophagograms following the injection of atropin sulphate (0.001 and

0.007 gr. intravenously) pilocarpin (0.001 gr. subcutaneously) and hypophysin, and found that the contractions in the normal and in the cancerous are the same. The tests are therefore without value for differential diagnosis. A great number of esophagograms are reproduced.—*T. Leucutia.*

JUNG, T-SHAN, and VAN ALLEN, C. M. A method of recording respiratory movements on a single roentgenogram. *Nat. M. J. China*, April, 1931, *17*, 195–199.

Tracings upon the fluoroscopic screen and roentgenograms made in inspiration and expiration are methods in general use which have proved the most efficient means of recording respiratory movements of the thoracic parietes. But these methods have proved expensive (in roentgenography), cumbersome, inaccurate and subject to error in interpretation.

The method presented is based upon the principal of double exposure photography, and the fact that repeated exposures may record the movement of relatively opaque tissue in a less opaque medium if the exposure time is varied with the density.

The technique for recording diaphragm and heart is similar, but to depict the rib movement which takes place in a relatively clear field a different technique is necessary.

For the heart and diaphragm the tube is centered over the xipho-sternal notch at 60 in., 40 ma., 154 kv., and with 0.5 sec. given as the usual time for exposure, 0.4 sec is used for the expiratory phase and 0.1 for inspiration.

To include a record of the rib movement a modification of the normal exposure is recommended of a $\frac{3}{4}$ ratio for expiration and $\frac{1}{4}$ for inspiration, centering over the mid-sternum.

Illustrations are shown with diagrams demonstrating the methods of outlining the amplitude of movement. Measurements on the diaphragms are taken at the points of greatest excursion. The third, sixth and ninth ribs are recorded in the arc of movement about a radius of 10 cm. from a central axis through bodies of their respective vertebrae.

This method allows accurate measurement and comparison of the respiratory movements of the thoracic parietes. It affords a permanent record, requires no special apparatus and is less expensive than the two film technique.—*Harold Thomas.*

ABDOMEN

ACKMAN, F. D. Multiple adenopapillomata of the stomach with report of case showing varying degrees of malignancy. *Canad. M. Ass. J.*, Sept., 1930, *23*, 391–399.

The author reviews the literature of this relatively rare condition of the stomach since it was first described by Cruveilhier in 1833. In regard to the incidence Eliason and Wright found that the lesion comprised 1.9 per cent of all benign gastric tumors. Carman recognized it in 2 cases in 50,000 gastric roentgen examinations. The average age incidence of the 89 cases reported was fifty-three years. There are two theories regarding the origin of these tumors. (1) Wechselman and Ribbert, Mayer, Hertz, Mueller, Roth and Rosenberger believe it to be due to "anlagen," while (2) Cornil, Verse, Hauser, Eliason and Wright, Basch, Strauss, Meyer and Bloom believe that irritation is the immediate underlying factor. The former theory is based on the familiar tendency of the tumor and the latter theory is based on the frequent association of this condition and chronic gastritis. Adenomata of the stomach have been produced experimentally in animals by irritation. Fibinger and Wassink used parasites while Ishabashi and Ohtani injected coal tar.

Pathology. The tumors are multiple, occurring usually in the distal third of the stomach and on the greater curvature. Menetrier classifies them as polyadenoma "polypeux" and polyadenoma "en nappe." The former type is the more common. It is characterized grossly by pedunculation and marked lobulation. The latter type is more uncommon. It is characterized by sessile, flattened plaques. Inflammatory reaction is extensive in both types of tumor. Malignant changes are not infrequently seen (15 per cent) particularly in the "en nappe" type. The symptoms are not characteristic, epigastric pain is the most frequent. Antemortem diagnosis is chiefly roentgenological. Treatment consists in total excision.—*J. H. Vastine.*

ACTION OF ROENTGEN RAYS AND RADIUM

ON THE

EYE AND EAR

EXPERIMENTAL DATA
AND
CLINICAL RADIOTHERAPY

BY

A. U. DESJARDINS

MAYO CLINIC

ROCHESTER, MINNESOTA

COMPLETED IN THREE SECTIONS

SECTION THREE

(For Section One, see October, 1931, issue)
(For Section Two, see November, 1931, issue)

CONTENTS

(Current Number, December, 1931)

EAR 73

General Considerations 73

Animal Experiments 73

Analysis of Experimental Data 76

Clinical Considerations 78

BIBLIOGRAPHY FOR EYE 84

BIBLIOGRAPHY FOR EAR 91

(Contents Published in the October and November Issues, 1931)

PREFACE

EYE 1

General Considerations 1

Animal Experiments 2

Analysis of Experimental Data 39

Clinical Considerations 51

Conclusions 67

ACTION OF ROENTGEN RAYS AND RADIUM ON THE EYE AND EAR

EAR

General Considerations

Few experiments have been conducted to test the effect of radiation on the organ of hearing. The possible influence of roentgen rays has received scant experimental attention, probably because no evidence of injury to the auditory apparatus of human beings has ever been reported. Investigation of the action of radium on the ear has been confined to the labyrinth.

Animal Experiments

Roentgen Rays. THIELEMANN (1928), without giving any technical details, stated that experimental roentgen irradiation of the petrous bone of white mice caused capillary hyperemia in the middle and internal segments of the ear. This hyperemia increased with the dose until, finally, perilymphatic hemorrhages appeared; such hemorrhages occurred chiefly in the basal windings of the cochlea and the region of the crista, and rarely in the macula. The reaction of the middle ear was characterized by serous exudation, followed by seropurulent secretion into the tympanic cavity, and by scattered hemorrhages.

Radium. EWALD (1905) placed a small glass ball about 2 mm. in diameter, containing about 3 mg. of radium bromide, in the region of the bony labyrinth of a number of animals.[98] This was done through a small opening in the skull so as to avoid disturbing the labyrinth. The ball was removed "after some hours."[99] Disturbances of the labyrinth became evident after several days; the grade of such disturbances was proportional to the duration of exposure and then remained constant. These disturbances of the labyrinth were characterized by turning of the head and other manifestations such as those which follow removal of the labyrinth. Similar glass balls without radium were introduced in the same manner into control animals, but disturbance of the labyrinth did not occur.

MARX (1909) attempted to study the effect of radium on the labyrinth of fifteen pigeons and seven guinea pigs.[100] Through an opening in the capsule of the right ear made in the anterior, lower quadrant of the large cross, in the pigeons, a glass capillary tube containing approximately 4 mg.[101] of radium was placed directly on the so-called foramen communicans. The left ear was left untouched for comparison. The wound was covered with cotton soaked in physiologic solution of sodium chloride. The pigeons were then placed in a cage, where they remained quiet for from half an hour to two hours, after which the radium capsule was withdrawn and the wound was closed with cutaneous sutures. This was never accompanied by inflammatory reaction, and all the animals recovered uneventfully. The right ear of nine pigeons was thus irradiated for one hour. One pigeon was decapitated[102] two weeks, one one month, one three months, one four months, one five and a half months, one six months, and one five months, after exposure to the radium, without having shown any evidence of abnormality during the interval.

The two other pigeons irradiated for one hour were decapitated[102] seven and a half and five months, respectively, after exposure. These animals remained normal for five and a

[98] The number and kind of animals was not stated.
[99] The duration of exposure was not otherwise specified.
[100] No mention was made of the age and sex of the animals.
[101] The quantity of radium was not accurately measured.
[102] Head fixed and hardened in 96 per cent alcohol, imbedded in celloidin, and serial sections made in frontal direction.

half and five and three-fourths months, respectively. The first animal then began to have recurring attacks, during which it fell forward on the thorax and had difficulty in righting itself, or ran forward until it struck the wall of the cage; when removed from the cage it ran normally. In the foot-bill position no difference in the beating of the wings could be perceived. When thrown into the air it flew awkardly in a small circle to the right. These attacks recurred at intervals of from two to five days, with normal intervals, for two weeks, when its head began to turn to the right, and it ran to the right in circles. The turning of the head to the right was especially marked when the animal was frightened. In the foot-bill position the left wing beat more vigorously than the right, and when the animal was suspended by the feet, the wing beat caused the body to turn strongly to the left. This pigeon did not fly spontaneously, and when thrown into the air it flew wildly in circles to the right. On turning to both sides, the nystagmus of the head, with and without a cap, was equal. Seven weeks later the foregoing symptoms began to subside and disappeared after two months. The second of these two pigeons remained normal for almost five months, after which the head turned markedly to the right, and this continued until the bird was decapitated.

The right labyrinth of four other pigeons was exposed to radium for two hours. Three of the animals did not give clinical evidence of disturbance of the labyrinth for six, seven, and six months, respectively, after exposure, and they also were killed by decapitation six and a half, eight, and twelve months, respectively, after irradiation. The fourth pigeon, exposed to radium for two hours, was decapitated one month later and remained apparently well during the interval. The right labyrinth of two other pigeons was exposed to the same quantity of radium for half an hour; in neither pigeon had manifestations of disturbance of the labyrinth developed when they were decapitated six months and three months, respectively, after exposure to radium.

Regardless of the clinical manifestations of disturbance of the labyrinth apparatus exhibited by thirteen of the fifteen pigeons, microscopic examination of all the structures of the labyrinth, as well as of the medulla and cerebellum, revealed nothing beyond simple atrophy of the sensory epithelium of the vestibule, which varied in degree in different portions and in different animals, and had no distinct relation to the duration of exposure. The epithelium was often well preserved although lower than normal, but sometimes the cells could not be recognized. The base of the crista acustica was covered with a low, undifferentiated band, with scattered nuclei and vacuoles, but this was generally absent over the apex which stood free from epithelial covering. The cupula had sloughed and usually lay free in the lumen of the ampulla. Pathologic changes were not found in the blood vessels, nerves, or ganglia. Even the region of the communicating foramen, where the radium had been placed, was normal. Cellular shrivelling of the vestibular ganglion was noted in some instances, but this was not confined to the irradiated side. Pathologic changes were not found in the two remaining pigeons.

In the seven guinea pigs a broad opening was made into the right middle ear through the so-called anterior sensory cavity. The radium capsule was placed directly on the apex of the cochlea, which projected freely into the middle ear, and was left in place for one hour. The radium was then withdrawn and the incision sutured. The reflex of the concha was always tested by the continuous tone series, but change was not found. With one exception, all the animals remained in normal condition until they were killed by decapitation from two and a half to six months after irradiation. As in the pigeons, microscopic examination showed more or less pronounced degenerative or atrophic changes, which affected chiefly the ganglion of Corti, but sometimes also the cochlear nerve and spiral ganglion. In some instances the apex of the ganglion of Corti was entirely destroyed and its place empty, or it was partly swollen and degenerated. High-grade atrophy of the cochlear nerve, with destruction of the medullary sheaths, was noted in several animals. The pathologic altera-

tions in the ganglion of Corti, cochlear nerve, and spiral ganglion affected chiefly the third spiral and sometimes also the second, but the basal portion was always intact. The irradiated labyrinth in two of the guinea pigs was entirely normal. One animal, which had not exhibited any abnormal manifestations for four months, suddenly had an attack during which the forward part of the body turned sharply to the right, and it sometimes ran to the right in circles. This was accompanied by pronounced nystagmus of the head and horizontal nystagmus of both eyes. These symptoms continued for about half an hour and were not repeated. Eleven days later the head inclined somewhat to the right, with the snout deviating slightly to the left, and this continued unchanged until death. Curiously enough, the only abnormality found on microscopic inspection of the irradiated labyrinth was swelling of the region of the cochlea, but this swelling also was found in the unirradiated left labyrinth. The sensory epithelium was lacking from the crista acustica externa and anterior, on the surface of which was a narrow double band containing vacuoles.

Marx concluded that the changes described were due to the action of radium and that the variation in the effects was due to a difference in the exact position of the radium capsule in the different animals. Attention was drawn to the exceptionally long latent period, so unlike anything observed in connection with the action of radiation on other tissues and organs, but this was left unexplained. That the changes noted had no relation to the duration of irradiation puzzled Marx not a little, but he took this to mean that the maximal effect of radium followed the shortest exposure.

Chilow (1927), seeking a method for the intravital isolation of the function of the otolith apparatus from that of the semicircular canals, sought to exclude the action of the otoliths by means of radium emanation. A definite dose of emanation in a glass ampule was introduced, under general anesthesia, into the tympanic cavity of three cats,[103] the wound was sutured, and the vestibular apparatus was examined "several hours or days later." The reaction of the semicircular canals to turning[104] was determined by the duration of nystagmus on turning to the right and left, and the reaction of the otoliths when the position of the animal was changed by the so-called otolith nystagmus described by Magnus, de Keijn, Voss and Mygind. Any difference in the duration of the nystagmus on turning the animal to right and left was regarded as due to the influence of radium on the semicircular canals. Placement of 18.48 millicuries of radium emanation was thus made in the left tympanic cavity of the first cat.[105] Three days later the animal was relaxed and would not eat. On forced movement it staggered to the left, and on springing from a chair it also turned to the left. Turning to the right in a Bárány chair, ten revolutions in twenty seconds, did not cause nystagmus, but turning to the left caused nystagmus to the right for ten seconds. Change of position, such as causing the animal to lie on the right or left side or on the back gave no evidence of otolith nystagmus. The vestibular reaction gave the same results. The animal died one week after the radium emanation had been introduced. Estimated according to the rate of disintegration of radium emanation the dose had, therefore, been 13.56 millicuries.

The labyrinth was treated by the method of Wittmaack. Microscopic examination of the cochlea disclosed marked infiltration of the scala tympani and scala vestibuli, with swollen polynuclear and mononuclear leucocytes and erythrocytes; marked hyperemia of the stria vascularis, the endothelial layer of which was thickened, infiltrated with inflammatory elements, and the contour of the cells indistinct; marked inflammatory infiltration of the basilar membrane; invisibility of the ciliary cells; indistinctness of the organs of Corti, which were represented by a shapeless mass; the lumen of the cochlear duct filled with coagulated lymph and a small number of leucocytes, and obliteration of the individual lobes of the spiral ganglion, which was infiltrated with mononuclear and polynuclear leuco-

[103] The age, sex and weight of the animals was not mentioned.
[104] Bárány chair.
[105] No mention was made of the duration of exposure.

cytes. The fibrous network of the vestibule was filled with erythrocytes, and the cavity of the utricle and saccule, with exudate and coagulated lymph and an accumulation of swollen polynuclear and mononuclear leucocytes. The maculae acusticae of the utricle and saccule also were greatly infiltrated with leucocytes and erythrocytes. It was impossible to recognize the supporting and sensory cells. The saccules were lacking from the otolithic membrane, and the cupulae also were absent. The lumen of the semicircular canals was filled with exudate and coagulated lymph.

Four millicuries of radium emanation[106] were similarly introduced, under general anesthesia, into the left tympanic cavity of a second cat. The animal gave no evidence of disturbed equilibrium for thirteen days, but the left pupil was contracted. Turning to the right caused nystagmus to the left for ten minutes. Turning to the left caused nystagmus to the right for fifteen minutes. Change of position did not yield any evidence of otolith nystagmus. Examination of the vestibule gave the same results. Because the nystagmus which resulted from turning the animal to the right was shorter than that which followed turning to the left, the conclusion was drawn that the function of the semicircular canals had been slightly affected, while the function of the vestibular sacs had not been disturbed. The absence of otolithic nystagmus indicated lack of injury to the vestibular sacs. Microscopic examination[107] of the labyrinth showed destructive changes in the cochlea; integrity of the vestibular sacs and semicircular canals; lymphocytic infiltration of the scala tympani of the basal convolutions of the cochlea; coagulated exudate and coagulated lymph throughout the windings of the cochlea; inflammatory infiltration of the wall of the modiolus; inflammatory infiltration of the ganglion of Corti, the basilar membrane and the stria vascularis; indistinct outline of the supporting and ciliary cells of the ganglion of Corti.

The left tympanic chamber of a third cat received in like manner 4.095 millicuries of radium emanation.[108] Five days later a spring caused the animal to turn slightly to the left. Being turned to the right caused slight nystagmus to the left for ten seconds; turning to the left caused active nystagmus to the right for ten seconds. Otolithic nystagmus did not follow change of position to the right or left side, but distinct rotatory nystagmus to the right ensued when the animal was placed on its back. Examination of the vestibular apparatus gave the same results. The shorter duration of the nystagmus on turning to the right was regarded as indicating a functional inhibition of the semicircular canals, and the otolith nystagmus in the dorsal position as indicating a disturbance of the utricle. Absence of otolithic nystagmus from lying on the right or left side was assumed to imply the integrity of the sac. Microscopic inspection[109] of the cochlea was thought to substantiate this interpretation by revealing the presence of coagulated lymph in the scala tympani and vestibuli, slight swelling and deformation of the supporting cells in the ganglion of Corti, partial filling with lymph of the vestibular cistern of the labyrinth, and coating of the otolithic membrane of the utricle and the cupula of one of the semicircular canals with an unbroken layer of coagulated lymph.

From these results Chilow concluded that radium is a valuable means of excluding the function of certain portions of the labyrinth; that radium may disturb the function of the semicircular canals, utricle, and cochlea, without influencing that of the saccule; that the possibility of isolating the function of the utricle from the semicircular canal system is doubtful, but that the sacculus may remain unaffected by radium rays.

Analysis of Experimental Data

Thielemann's failure to give a detailed description of his experiments renders it impossible to analyze the factors which may have been responsible for his observa-

[106] The emanation actually absorbed was given as 1.72 millicuries.
[107] Intravital fixation according to Beck, Joshii, and Iwata. Labyrinth treated by the method of Wittmaack.
[108] The emanation absorbed was given as 2.484 millicuries.
[109] Intravital fixation. Labyrinth treated by the method of Wittmaack.

tions. The results were possibly caused by irradiation, but the precise relationship must remain a matter for conjecture.

The experiments of Ewald (1905) were so limited and the information concerning them is so meager that they can hardly be said to throw much light on the subject. Moreover, failure to submit the labyrinth of the irradiated animals to microscopic examination and dependence on clinical manifestations by which to judge the influence of radiation on the delicate structures of the labyrinth cannot be regarded as a satisfactory scientific test. Especially is this true in the light of the experiments of Marx (1909). Marx deduced from the results of his studies that radium was the cause of the clinical manifestations noted in a few of his pigeons and of the atrophic changes in the labyrinth observed in most of his animals. On close analysis, however, this deduction cannot be accepted. Only three of the fifteen pigeons and one of the guinea pigs exhibited manifestations of disorder of the irradiated labyrinth. Moreover, the labyrinthine disturbance in the three pigeons did not become apparent until five and a half, five and three-quarters, and six months, respectively, and in the single guinea pig until four months, after the affected labyrinth had been exposed to radium. This prolonged latent period is entirely inconsistent with the known mode of action of radium on living tissue generally. This evidence alone, however, would hardly be sufficient to negative the deduction of Marx, if still more conclusive data had not been furnished by Marx himself in the careful descriptions of the pathologic alterations of the labyrinth noted by him in all but two of the irradiated animals. The chief structural disturbance found on microscopic inspection of the labyrinth of the pigeons was atrophy of the sensory epithelium of the vestibule, especially around the crista acustica, the upper portion of which was often devoid of epithelium, while the cells covering the lower portion were generally lower than usual. The pathologic changes in the guinea pigs were of the same character, but affected chiefly the ganglion of Corti, the cochlear nerve, and spiral ganglion. Two interesting and important points are that histologic abnormality was not found in the region of the communicating foramen, where the radium had been placed, and that the extent and degree of the morphologic alterations bore no relation to the duration of exposure to radium. It is well known that the influence of radium on living tissue is greatest in the immediate vicinity of the radioactive substance, that such influence manifests itself within from two to four weeks by more or less pronounced degenerative cellular changes, and that these changes are followed by regeneration of cells or by replacement by connective tissue of cells injured beyond the possibility of regeneration. Also the extent and degree of the cellular degeneration are proportionate to the dose of radium. Since the experiments of Marx do not show any such relationship his conclusion that radium was responsible for the abnormalities described is invalid; it is more likely that they were due to the mechanical effect of the radium container or to the operative intervention incident to the introduction and withdrawal of the radium. Additional evidence that the histologic abnormalities noted had another cause than radium is to be found in the only guinea pig which presented clinical manifestations of disturbed function of the labyrinth and in which similar pathologic alterations were found in the unirradiated as well as in the irradiated organ.

The experiments of Chilow also are inconclusive. While there appears to be a certain relationship between the dose of radium and the character, extent, and degree

of the clinical disturbances and microscopic abnormalities, the small number of animals employed and the failure to provide adequate controls make it possible that the clinical and pathologic changes described may have been a mechanical effect of the glass container rather than of its radioactive content. The tympanic cavity is probably rather intolerant of foreign bodies, and the untested effect of this factor diminishes the value of Chilow's experiments.

Clinical Considerations

The number of communications in medical records on the influence of roentgen and radium rays on diseases of the ear is far from negligible, but the character of many is hardly scientific. Numerous others, however, give evidence of careful work and deserve more than passing attention.

Eczema and Perichondritis of the External Ear. Thost (1914) mentioned four cases of eczema of the external ear, in one of which the condition was cured, and in two others rapidly improved, by roentgen-ray treatment; the fourth patient also improved, but discontinued treatment. Two other patients suffering from perichondritis were reported to have been cured in a short time. Forschner (1926) also described a patient afflicted by acute inflammation of the concha, who derived rapid relief from pain and inflammation from a single exposure to 2 Holzknecht units of roentgen rays (one-sixth of the skin erythema dose) filtered through 0.5 mm. of zinc. Urbantschitsch (1915) reported one case of eczema of the auditory canal in which cure was effected by treatment with radium.

Hematoma of the External Ear. The "cauliflower" ear of the pugilist is well known and is due to rupture of blood vessels from blows, with accumulation of blood between the cartilage and its perichondrium or in the cartilage itself. The condition is not confined to pugilists; it may result from any sharp blow on the ear, or may occur spontaneously. No one had even thought it possible that irradiation could have any effect on such hematomas until Forschner and Regnier (1923) demonstrated the usefulness of roentgen rays by reporting two cases with hematoma of the concha which they had cured in this manner. They held roentgen-ray treatment superior to surgical puncture, over which it had the advantage of not interfering with the activities of the patient. Forschner (1924) recorded another case, and Forschner (1924) cited two additional cases of hematoma of the concha rapidly cured by exposure to roentgen rays, and with cosmetic results superior to those obtainable by surgical means. Forschner and Regnier (1925) reported twenty-three cases, in all but two of which treatment had been successful; the patients included porters, mail carriers, millers, boxers, and wrestlers. The roentgen-ray treatment consisted in exposing the external ear to 3 Holzknecht units of roentgen rays filtered through 3 or 4 mm. of aluminium, after which the hematoma regressed rapidly. Only a few patients had to be treated more than once. Forschner and Regnier insisted on the importance of early treatment, and added that the result was characterized by absence of organization of the connective tissue except at the point of fracture of the cartilage. The remarkable influence of irradiation on young connective tissue, proved experimentally by Hesnard, undoubtedly has much to do with the regression of auricular hematoma described by Forschner.

Tuberculosis of the External Ear. Thost (1914) appears to have been the first to submit evidence that exposure to roentgen rays may benefit lupus of the external

ear. He described the condition of two patients with lupus of the concha, who had been cured by repeated roentgen irradiation. Urbantschitch (1915) also reported the cure by radium treatment of a patient with tuberculous ulcers of the concha; the ulcers healed in spite of an inflammatory reaction probably due to excessive irradiation.

Otitis Media. Dionisio (1906) seems to have been the first to test the therapeutic value of roentgen rays in otitis media. He treated twenty patients suffering from chronic suppurative inflammation of the middle ear and reported that sixteen had been cured and were well when last seen, from three months to three years later. The hearing of many of these patients also was claimed to have improved. Beattie (1921) recorded fourteen cases of subacute or chronic otitis media in which cure or improvement had soon followed roentgen-ray treatment. The disease of four infants, who had been treated only with small doses, subsided, but did not disappear completely. Fifteen other patients treated by Dempster were included in Beattie's report; in five cases the discharge ceased after a single treatment, and in one case, in which the disease had existed ten years, it subsided after four irradiations. Beattie added that the kind of pyogenic bacteria present did not seem to affect the result. Szasz (1922) gave roentgen-ray treatment to ten children who had chronic purulent otorrhea; four were reported as having been cured in from three to twenty-one days; two others, whose disease had subsided after treatment, suffered a relapse, but renewed treatment caused the discharge to disappear permanently. Other methods of treatment were found more effective than roentgen rays in the remainder of the patients. Raynal (1923) described three patients afflicted with chronic disease of the middle and internal ear; in one patient the condition in the right ear had lasted three years and was accompanied by headache, vertigo, loss of equilibrium, and deafness. Three courses of roentgen-ray treatment[110] were said to have yielded distinct improvement. The two other patients had been completely deaf for a long time, but their hearing returned sufficiently to enable them to hear an alarm clock, and the improvement was noticeably greater in the ear last involved. Grande (1925) reported fifteen cases of recent catarrhal inflammation of the middle ear; all of the patients were regarded as having improved after one exposure to roentgen rays. The tinnitus also was said to have subsided and the impairment of hearing to have diminished.

Yocom (1925) presented thirty-five cases of chronic inflammation of the middle ear, in all but two of which cure had been effected by roentgen-ray treatment, although in some instances the disease had been present many years. The hearing of some of the patients was thought to have increased. The treatment consisted in exposing the auditory and mastoid regions five or six times at intervals of one week and then every second week to roentgen rays generated at 140 peak kilovolts, filtered through 0.5 mm. of copper and 1 mm. of aluminium, at a focal-skin distance of 12 inches. Denman (1925) wrote favorably of the effect of radiation on diseases of the middle ear, without giving tangible evidence. Di Donato (1926), reporting the results of roentgen-ray treatment[111] in seventy-five cases of otorrhea and chronic suppurative otitis media, noted an initial increase, followed by a decrease, in the discharge; also that the number of bacteria in the discharge

[110] 10 Holzknecht units in five days, repeated in one month, and 8 Holzknecht units one month later.

[111] 12 Holzknecht units at each of seven daily sessions. Rays generated at a voltage equivalent to a spark-gap of 30 cm.

diminished steadily, but did not disappear completely. From this he deduced that roentgen rays cannot control the disease absolutely. TURANO (1927) treated twelve victims of chronic purulent otitis media by the Ghilarducci method of secondary radiation; eight were cured and the four others improved slightly. Four patients exposed to roentgen rays without secondary radiators, and four treated with secondary radiators, without roentgen rays, were said to have received only slight benefit. Urbantschitsch (1912) failed to note any amelioration in patients with diffuse suppuration of the middle ear treated with radium. On the other hand, three patients suffering from granulation were benefited, and one patient suffering from caries was cured in fourteen days. Urbantschitsch also reported that ulcers of the middle ear were not influenced by radium, but that ulcers of the auditory canal and concha yielded brilliant results.

The foregoing reports indicate that an uncertain percentage of patients with acute, subacute, or chronic catarrhal, suppurative or atrophic disturbances of the middle ear are susceptible of deriving a measure of benefit from radiotherapy and that some may thus be permanently cured. Little if any evidence is available, however, to throw light on the mode of action of the rays. Such action probably involves the lymphocytes which may constitute an important element of the inflammatory deposits and of neighboring hyperplastic lymphoid structures. The known variation in lymphocytic infiltration may, indeed, explain the failure of radiotherapy in many cases.

Otosclerosis. Otosclerosis has always been regarded as a chronic condition which progresses irregularly in spite of treatment. It is surprising, therefore, to find in the literature so many reports in which improvement in symptoms is claimed. JAULIN (1908) gave from 1 to 2.5 Holzknecht units of roentgen radiation each week to ten patients suffering from otosclerosis, with impaired hearing and tinnitus. The rays were directed to the ear drum through a small speculum. The hearing was said to have improved slightly in five cases, and the tinnitus disappeared in three others, but the disease did not appear to be affected in the remainder. SCHWARTZ (1910) described three patients treated with roentgen rays: one, a sixteen-year-old gymnast, was cured after six irradiations at monthly intervals; the condition of a second patient improved, and that of the third was not influenced. WEBSTER (1921) recorded two patients treated by the method of Siebenmann; the hearing of one patient did not improve, but remained stationary, while that of the other increased slightly. As pointed out by BARWELL (1921), Webster's report was probably premature, because stationary periods in the progress of otosclerosis are well known. LÜDIN (1921) had gathered the impression that roentgen-ray treatment caused the hearing to improve and the tinnitus to diminish, but did not describe the cases on which this impression was based. FREY and KRISER (1923), on the unfounded assumption that otosclerosis results from functional deficiency of the parathyroid glands, treated fifteen patients by giving a small dose of radiation to the parathyroid glands and a large dose to the ear and hypophysis, and claimed that the progress of the disease was arrested, the hearing increased, and the tinnitus diminished in the majority. Grande (1925) treated five patients suffering from otosclerosis; the tinnitus of two was relieved, but change in hearing could not be perceived. Another patient, whose condition had lasted a long time and who had received much fruitless treatment, apparently experienced improvement in hearing after exposure

to roentgen rays. KRISER (1925) reported having treated thirty-eight patients. The roentgen rays were directed to the preauricular and postauricular regions through two fields, each of which received from 2 to 3 Holzknecht units of radiation generated at 130 kilovolts and filtered through 0.3 mm. of zinc; this was repeated three times at intervals of two months, and the thyroid gland also was irradiated. The acuity of hearing increased markedly and the tinnitus disappeared in eight cases. Arrest of the disease, without actual improvement, occurred in ten cases, and no effect was noted in twenty cases. Kriser thought the improvement was partly due to the action of the rays on the thyroid and pituitary glands. RÉVÉSZ and KÖVARI (1926–1927), who treated twenty-five patients by exposing each ear, through a preauricular and postauricular field, to 50 per cent of an erythema skin dose of rays filtered through 5 mm. of aluminium and repeated the treatment two months later, claimed that the majority of patients were benefited. The hearing was reported as improved in only eight cases; Kriser obtained the best results during the early stages of the disease. ORTLEFF (1913) and KINNEY (1923), on the contrary, did not find improvement in any of the cases of otosclerosis treated by them.

BECK (1904) placed radium in the auditory canal of a patient afflicted with otosclerosis, but improvement did not ensue. LAKE (1912) cited the instance of a young woman aged nineteen, in whom radium treatment caused the hearing to be partly restored and the disease to be arrested. BRYANT (1914) used radium in nine cases of otosclerosis, and apparently careful tests of auditory function were made. Partial or complete relief from tinnitus and improvement in hearing were said to have occurred, but the duration of this effect was not mentioned. BOONACKER (1914–1915) also treated twenty patients suffering from otosclerosis. The hearing of two patients was subjectively and objectively improved; the tinnitus of two patients ceased for at least six weeks. The tinnitus of one patient diminished, and that of three others decreased, but the hearing remained unchanged.

It is difficult to understand how a disease such as this can be influenced to any great extent by roentgen or radium rays. The evidence furnished by some of the foregoing reports is not substantial, and some of it is worthless. Moreover, the assumption of an interrelationship between otosclerosis and certain hypothetical disturbances of the pituitary and parathyroid glands cannot be said to have much foundation. Many of the cases of otosclerosis in which improvement in symptoms was reported to have followed roentgen-ray or radium treatment must, therefore, be excluded. Especially is this true with reference to hearing, because the impression or opinion of the patient is notoriously prone to be affected by suggestion. This is a field of therapeutics in which post hoc propter hoc deductions have been legion. Having made these ample reservations there remains, nevertheless, a certain proportion of patients who appear to have been unquestionablybenefited. It is noteworthy also that the tinnitus seems to have been influenced more than the impairment of hearing. The details given in most of the reports are so meager that the difference in results between thorough and well-planned and inadequate and ill-planned treatment cannot be clearly discerned. It is certain that in several instances the treatment was crude. For all these reasons a conclusive explanation of the mode of action of roentgen and radium rays on the otosclerotic process cannot be made. It is probable that the cases in which radiotherapy is followed by improvement are those in

which the disease is associated with chronic inflammatory changes and a measure of leucocytic infiltration. This would explain the improvement.

Impaired Hearing and Tinnitus. McCulloch (1913) drew attention to the possible benefit to be derived from roentgen irradiation by citing the instances of four patients with extreme labyrinthine deafness, whose condition had been slightly improved in this manner. The hearing of these four patients had been tested independently by Wood. Bryant (1914) tested the therapeutic effect of irradiation on nine patients with otosclerosis, twelve with chronic atrophic otitis media, thirteen with chronic suppuration of the middle ear, four with chronic hypertrophic inflammation, and two with nonsuppurative labyrinthitis; in all, forty ears. Apparently careful tests of the auditory function were made. Improvement in hearing was said to have occurred in thirty-three ears; the impairment greatly diminished in fourteen ears, and disappeared completely in six others. The treatment had no apparent effect on the remainder. Bryant did not give any data on the duration of improvement. Boonacker (1914–1915) stated that he had treated thirty-five patients with early otosclerosis and dry catarrh of the middle ear, and one patient with otitis media with dry perforation. He claimed subjective and objective improvement in the hearing of two patients, diminished tinnitus of one patient, disappearance of tinnitus for at least six weeks of two, and decrease in tinnitus without alteration in hearing of three other patients.

The question of the therapeutic influence of irradiation on pathologic conditions associated with impairment of hearing and tinnitus was thus being investigated when, in the course of a discussion on the relation of the endocrine system to deafness, Stokes (1921) stated that "electronic equilibrium" was the governing factor in metabolism, and claimed that deafness could be readily cured by "electronizing" the pituitary and auditory regions with very small, "ionizing" doses of roentgen rays. Miller (1921) supported this by claiming that fifteen patients suffering from deaf-mutism or otosclerosis treated by Stokes had been cured or improved. Data were not presented to substantiate these claims. McCoy (1923) reported having tried the Stokes method in forty-five cases of defective hearing from chronic dry catarrh, chronic purulent otitis media, and otosclerosis. The hearing was tested by watch, acoumeter, voice, and whisper before and after treatment, and the patency of the eustachian tubes was noted. Slight or great improvement in hearing and tinnitus in all but nine cases was claimed, and McCoy attributed this effect to the influence of the rays on the infiltrating lymphocytes.

Jarvis (1923) was not so sensational and noted improvement in hearing and tinnitus only of patients with lymphoid hyperplasia in the throat accompanied by rhinitis. He found small doses of roentgen rays sufficient, but could not believe that such doses could have so great an effect on the lymphocytes, and attributed the improvement to an action of the rays on the bacteria responsible for the disturbance. Kinney (1923) found roentgen rays ineffective in otosclerosis, but often successful in diminishing or relieving the tinnitus caused by chronic inflammation of the nasopharynx. He recorded fourteen cases of tinnitus from chronic otitis media, in six of which roentgen-ray treatment was followed by partial relief from tinnitus and improvement in hearing. Stein (1924) tested the therapeutic value of roentgen rays from the point of view of the otolaryngologist by treating one series of patients with small doses and another series with large doses. For the small dose he used a voltage

equivalent to a spark-gap of 4 inches, a current of 3 or 4 milliamperes, a distance of 35 inches, and a filter of 3 mm. (presumably aluminium). For the strong dose he employed a voltage equivalent to a spark-gap of 7 inches, a current of 4 milliamperes, and a distance of 10 or 12 inches. The rays were directed to the auditory canal and surrounding territory through a small opening in a lead plate, and also to the pituitary region through the mouth. The effect of small doses was nil, but after large doses distinct improvement was noted in several cases of catarrhal inflammation and otosclerosis, and in at least two the symptoms were completely relieved. The tinnitus was sometimes relieved, but change in hearing could not be found in cases of nerve deafness. From Stein's analysis it is clear that the best results were obtained in cases of lymphatic hyperplasia around the throat, adenoids, and tonsils. Nervous deafness and advanced otosclerosis did not respond to treatment.

Albrecht (1913–1914) treated with radium eleven patients with ankylosis of the stapes, eight with nervous deafness, and two with chronic catarrh, nearly all of whom suffered from tinnitus and dizziness. The tinnitus usually diminished more or less, and sometimes the relief was pronounced for a time, but recurrence was common. Sobotky (1917), an otologist, treated twenty-five patients suffering from tinnitus and deficient hearing with 0.0001 gm. of radium bromide. The hearing tests were made independently by an assistant. Increase in auditory acuity was noted in five cases, and increase in auditory disability in six. The tinnitus ceased in one case, diminished in ten cases, and increased in two. Meyjes (1914) reported having treated about 100 patients afflicted with partial or complete deafness with 1 mg. of mesothorium. The mesothorium was placed in the auditory canal for from one and a half to two and a half minutes six times every three days. No evidence of injury was ever found, and subjective improvement was noted in the majority of cases. Meyjes attributed the result to slight stimulation, but did not specify the structures thus stimulated. Passow (1914), on the contrary, obtained perceptible improvement of only a few of the 100 deaf patients whom he treated with radium, and such improvement was never greater than could be obtained by other methods. Haenlein (1913–1914), who treated twenty-nine patients afflicted with deafness and tinnitus with radium preparations of different strength and who tested the hearing carefully so as to avoid possible suggestion, could not observe any improvement. Dreyfuss (1914) also tested the effect on deafness and tinnitus of 0.6 mg. of radium wrapped in cotton and applied to the concha or mastoid for from three to ten minutes. He also treated some patients with 0.04 mg. of radium in a glass capsule placed in the auditory canal, but without any benefit. Burger (1916) was the only one to report a deleterious effect on hearing and increase in vertigo after placing in the auditory canal 1 mg. of mesothorium for one minute. It is impossible to conceive how the increase in symptoms following such a dose could have been anything more than a coincidence, unless it was due to the mechanical effect of the container.

The foregoing evidence is difficult to analyze, because so few of the reports contained adequate data. Moreover, some authors accepted the impressions of the patient as a criterion of the therapeutic effect of radiation, and their claims must be denied for this reason. The pretensions of Stokes, Miller and McCoy are mentioned only for their slight historic interest. But aside from these exclusions, there still remain clear indications that irradiation may influence tinnitus especially, but sometimes may exert a favorable action on hearing also, and that such benefit as

may be derived appears to be due to the effect of the rays on leucocytes infiltrating the lesions around the ear, throat, and nasopharynx, which may be partly or wholly responsible for the auditory symptoms. From some of the records cited it is clear that the treatment was often crudely conducted, and this must undoubtedly have accounted for some of the failures.

Tuberculosis of the Middle Ear. CEMACH (1922) treated with roentgen rays thirteen patients with tuberculosis of the middle ear and claimed good results, but gave no details except that the patients were also exposed to ultraviolet rays. BONDY (1927) cited the interesting case of a boy aged four and a half years, with tuberculosis of the middle ear, who was cured by roentgen-ray treatment.

Conclusions

The animal experiments undertaken to test the radiosensitiveness of the auditory apparatus relate chiefly to the effect of radium on the labyrinth and are not conclusive. Pathologic changes thought to represent the action of radium on the labyrinth were probably due to the mechanical effect of the radium container or to the surgical intervention incident to the introduction of the radium capsule.

If the animal experiments on the radiosensitiveness of the ear have been few in number, the clinical applications, on the contrary, have been numerous and have included most of the diseases affecting this organ, such as eczema, perichondritis, hematoma, and lupus of the external ear; acute, subacute, and chronic catarrhal, hypertrophic, and atrophic inflammation of the middle ear; otosclerosis and tuberculosis of the middle ear, and tinnitus and deafness from various causes. Although much of the evidence that radiation exerts a favorable influence on these different conditions is unsatisfactory and unconvincing and some of it is wholly worthless, many of the recorded instances of cure or improvement following radiotherapy are sufficiently explicit to show that roentgen and radium rays may often render useful and sometimes great therapeutic service. This seems to be especially true of pathologic conditions in which leucocytic infiltration or lymphoid hyperplasia are a significant factor.

BIBLIOGRAPHY FOR EYE

1. ABELSDORFF, G. Die Wirkung des Thorium X auf das Auge. *Klin. Monatsbl. f. Augenh.*, 1914, *18*, 321–334.
2. ALLPORT, FRANK. A case of vernal conjunctivitis. *Ophth. Rec.*, 1903, *12*, 484–487; Vernal conjunctivitis. *Ophth. Rec.*, 1904, *13*, 557.
3. AUBINEAU and CHUITON. Lupus de la conjonctive et de la cornée guéri par la radiothérapie. *Arch. d'élect. méd.*, 1908, *16*, 48–52.
4. AXENFELD. Kombinierte operative und Strahlentherapie traumatischer sog. Iriszysten. *Deutsche med. Wchnschr.*, 1917, *43*, 1182–1183.
5. BAERMANN, GUSTAV, and LINSER, PAUL. Ueber die lokale und allgemeine Wirkung der Roentgenstrahlen. *München. med. Wchnschr.*, 1904, *51*, 996–999.
6. BECK, J. C. Radium in trachoma. *Ann. Ophth.*, 1905, *14*, 478–481.
7. BELLEY, G. H. Étude expérimentale de l'action des rayons X sur l'oeil en voie de développement. Bordeaux, 1907, 86 pp.
8. BENNETT, H. C. Roentgen-ray conjunctivitis. *J. Phys. Therap.*, 1905–1906, *1*, 384–386.
9. BENSON, F. C., and CLAY, J. V. F. A case of Parinaud's conjunctivitis treated with radium. *J. Ophth. & Oto-Laryngol.*, 1921, *25*, 209–213.
10. BETTREMIEUX. Rayons X en thérapeutique oculaire. *Clin. Opht.*, 1903, *9*, 225–227.
11. BIRCH-HIRSCHFELD, A. Die Wirkung der Röntgen- und der Radiumstrahlen auf das Auge. *Arch. f. Ophth.*, 1904, *59*, 229–310.
12. BIRCH-HIRSCHFELD, A. Klinische und anatomische Untersuchungen über die Wirkung des Radiums auf die trachomatöse Bindehaut. *Klin. Monatsbl. f. Augenh.*, 1905, *2*, 497–513.

13. Birch-Hirschfeld, A. Nachtrag zu der Arbeit über die Wirkung des Radiums auf die trachomatöse Bindehaut. *Klin. Monatsbl. f. Augenh.*, 1905, *2*, 546–548.
14. Birch-Hirschfeld, A. Weiterer Beitrag zur Wirkung der Röntgenstrahlen auf das menschliche Auge. *Arch. f. Ophth.*, 1907, *66*, 104–119.
15. Birch-Hirschfeld, A. Zur Wirkung der Röntgenstrahlen auf das menschliche Auge. *Klin. Monatsbl. f. Augenh.*, 1908, *46*, 129–137.
16. Birch-Hirschfeld, A. Der therapeutische Verwendung der strahlenden Energie in der Augenheilkunde. *Ztschr. f. Augenh.*, 1922–1923, *49*, 48–50.
17. Bossuet, A. Experimentelle Untersuchungen über die Einwirkung der Röntgenstrahlen auf die Linse. *Arch. f. Augenh.*, 1909, *64*, 277–285.
18. Brandes: Quoted by Cowl, W. Ueber die "Sichtbarkeit der Röntgenstrahlen." *Arch. f. Anat. u. Physiol. Abteil.* 1897, pp. 397–402.
19. Brandt, Leo, and Fraenkel, Manfred. Verödung der Tränendrüse durch Roentgenstrahlen. *Deutsche med. Wchnschr.*, 1922, *48*, 159–160.
20. Braun, Georg, and Herrnheiser, Gustav. Röntgenbehandlung der Choroiditis tuberculosa. *Klin. Monatsbl. f. Augenh.*, 1927, *79*, 187–197. Abstr. in: *Zentralbl. f. d. ges. Ophth.*, 1928, *19*, 294.
21. Broeman, C. J. Radium treatment in diseases of the eye and adnexa. *Ohio State M. J.*, 1925, *21*, 257–263.
22. Bunting, T. L. Roentgen rays in treatment of ulcerative blepharitis. *Lancet*, 1907, *1*, 1014.
23. Butler, T. H. Catarrhe printanier; cellules éosinophiles et traitement spécifique par le radium. *Clin. Opht.*, 1916, *21*, 469–475.
24. Butler, T. H. Some remarks upon spring catarrh; with special reference to its diagnosis and its treatment with radium. *Brit. J. Ophth.*, 1917, *1*, 411–415.
25. Bywater, H. H., and Plummer, F. C. Preliminary note on the X-ray treatment of interstitial keratitis. *Brit. M. J.*, 1923, *2*, 1152.
26. Cassidy, H. F., and Rayne, F. C. Trachome chronique très amélioré par les rayons X. *Ann. d'électrobiol.*, 1903, *6*, 617–619.
27. Cautley, Edmund, and Harman, N. B. Optic neuritis (?) due to X-rays. *Proc. Roy. Soc. Med.*, 1916, *9*, 3–5.
28. Chalupecky, H. Ueber die Wirkung der Röntgenstrahlen auf das Auge und die Haut. *Zentralbl. f. prak. Augenh.*, 1897, *21*, 234–239; 267–271.
29. Chalupecky, H. Die Wirkung des Radiums und der Radiumemanation auf den Sehapparat. *Wien. klin. Rundschau.*, 1911, *25*, 821–824.
30. Cohen, Martin, and Levin, Isaac. The action of radium on cataracts. *J. Am. M. Ass.*, 1919, *73*, 1193–1200.
31. Cohn, H. Radiumwirkungen bei Bindehautgranulationen. *Jahresb. d. schles. Gesellsch. f. vaterl. Kult.* Bresl., 1906, 24–28.
32. Cohn, Hermann. Die Heilung des Trachoms durch Radium. *Berl. klin. Wchnschr.*, 1905, *42*, 22.
33. Coleman, W. F. The X-ray and some personal observations of its use in diseases of the eye. *J. Ophth. & Oto-Laryngol.*, 1907, *1*, 125–133.
34. Cook, F. R. The action of intermittent X-rays on general metabolism and chronic degenerative diseases of eye. *Med. Rec.*, 1910, *77*, 779–785.
35. Coover, D. H. Roentgen-ray flashes or intermittent X-rays in the treatment of eye diseases with report of cases. *Ophth. Rec.*, 1909, *18*, 331–338.
36. Corbett, J. J. The effect of radium on glaucoma. *Boston M. & S. J.*, 1924, *190*, 1124–1126.
37. Cochard, M. La radiothérapie du trachome. Lyon, 1921, 59 pp.
38. Coutard, and Offret. Traitement de la conjonctivite folliculaire par les rayons X très filtrés. *Ann. d'ocul.*, 1920, *157*, 240–244.
39. Cuperus, N. J. Mesothorium Beleuchtung bei Augenkrankheiten. *Arch. f. Augenh.*, 1914, *77*, 1–6; Mesothorium treatment of eye diseases. *Arch. Ophth.*, 1917, *46*, 126–129.
40. Darier, A. Röntgenstrahlen und Becquerelstrahlen in der Augentherapie. *Wchnschr. f. Therap. u. Hyg. d. Auges.*, 1902–1903, *6*, 409.
41. Davidson, J. M., and Lawson, A. A case of spring catarrh treated and cured by radium. *Tr. Ophth. Soc. U. Kingdom*, 1908–1909, *29*, 239–245.
42. De Courcy, T. L., and Mather, J. H. X-ray treatment of interstitial keratitis. *Brit. J. Radiol.*, 1924, *29*, 105–109.

43. Derby, G. S. X-ray and radium in the non-malignant diseases of the eye. *Boston M. & S. J.*, 1924, *191*, 20–21.
44. Deutsch. Radiumbestrahlung bei hämorrhagischen Glaukom. *Klin. Monatsbl. f. Augenh.*, 1928, *80*, 104.
45. Dinger, A. N. Beitrag zur Behandlung des Trachoms mit Radium. *Berl. klin. Wchnschr.*, 1906, *43*, 1311–1313.
46. Dorn, E. Zur Frage der Sichtbarkeit der Röntgen-strahlen. *Arch. f. Anat. u. Physiol. Abteil.*, 1897, 544–548.
47. Ehnhuus, E. Et Tilfaelde af overfladiske og dybe ojenlaesioner opstaaede under Bestraaling med. Röntgenstraaler. *Hosp.-Tid.*, 1919, *52*, 1228–1230.
48. Esdra, C. Risultati della cura di alcuni casi di tracoma mediante il radio. *Boll. d. osp. oftal. d. prov. di Roma*, 1906, *4*, 23–25.
49. Falta, M. Das Radium in der Trachomtherapie. *Wien. med. Wchnschr.*, 1905, *55*, 1546–1551.
50. Fellows, C. G. Clinical reports on the Roentgen ray flashes. *Homoeop. Eye, Ear & Throat J.* 1910, *16*, 389–391.
51. Fischoeder, Eduard. Über Schädigungen am vorderen Augenabschnitt durch Röntgenstrahlen an einem wegen Aderhautsarkoms bestrahlen Bulbus. *Ztschr. f. Augenh.*, 1920, *44*, 160–166.
52. Flaschenträger, Heinrich. Beitrag zur Radium- und Röntgenschädigung des menschlichen Auges. *Klin. Monatsbl. f. Augenh.*, 1924, *72*, 645–648.
53. Flemming. Experimentelle und klinische Studien über den Heilwert radioaktiver Strahlen bei Augenerkrankungen. *Arch. f. Ophth.*, 1913, *84*, 345–400.
54. Flemming and Krusius. Zur Einwirkung "strahlender Energie" auf die experimentelle Tuberkulose des Auges. *Deutsche med. Wchnschr.*, 1911, *37*, 1600.
55. Fortunati, A., and Esdra, C. Il trattamento radiumterapico contro il tracoma e le modificazioni istologiche indotte dal radium. Sul neoplasma tracomatoso. *Ann. d. ottal.*, 1908, *37*, 159–177.
56. Franklin, W. S., and Cordes, F. C. Radium for cataract. *Am. J. Ophth.*, 1920, *3*, 643–647.
57. Frogé, P. Recherches sur l'action des rayons X sur l'oeil. Paris, 1922, pp. 45.
58. Geisel, F. Quoted by London, E. S. L'action physiologique et pathologique des produits du radium. *Arch. d'élect. méd.*, 1904, *12*, 614–627.
59 Geyser, A. C. The successful treatment of eighteen cases of granular lids by the X-ray and high-frequency vacuum electrodes. *Am. Therap.*, 1903–1904, *12*, 41–43. *J. Advanc. Therap.*, 1904, *22*, 299–302.
60. Goldzieher, W. Ueber die Einwirkung der Röntgen-Strahlen auf die trachomatöse Infiltration. *Wien. med. Wchnschr.*, 1904, *54*, 822–824.
61. Gonzalez, Leon J. de J. Los rayos X en la terapeutica de la periquerato-conjunctivitis exuberante. *Rev. cubana de oftal.*, 1920, *2*, 125–131.
62. Gonzalez, Leon J. de J. Vegetacion gigante reincidente de periquerato-conjunctivitis, que invadio la cornea y cedio a los rayos X. *Rev. cubana de oftal.*, 1920, *2*, 131–133.
63. Greeff, R. Ueber Radiumstrahlen und ihre Wirkung auf das gesunde und blinde Auge. *Deutsche med. Wchnschr.*, 1904, *30*, 452.
64. Greeff, R. Antwort an E. S. London, betreffend die Wirkung der Radiumstrahlen auf das blinde Auge. *Deutsche med. Wchnschr.*, 1904, *30*, 1032.
65. Guarini, Carlo. La cura roentgen di alcune lesioni dell'occhio con le radiazioni a cortissima lunghezza d'onda. *Riforma med.*, 1922, *38*, 963–964.
66. Guglianetti, L. Il radium nella cura del catarro primaverile. (Communicazione preventiva.) *Boll. d. osp. oftal. d. prov. di Roma*, 1908, *6*, 115–116.
67. de Guilleuma, S. Electroionisation par le radium dans la conjonctivite printanière. *Clin. Opht.*, 1918, *8*, 706–714.
68. Handmann, M. Vollständige Rückbildung einer traumatischen Iriszyste nach Röntgenbestrahlung. *Klin. Monatsbl. f. Augenh.*, 1924, *72*, 111–116.
69. Harman, N. B. Electrical treatment of trachoma. *Brit. M. J.*, 1905, *2*, 435.
70. Hensen, and Lorey. Ueber die Behandlung des Tränenträufelns durch Röntgenbestrahlung der Tränendrüse. *München. med. Wchnschr.*, 1922, *69*, 1573.
71. Hensen, H., and Schäfer, H. Über die Ergebnisse der Röntgenstrahlenbehandlung bei Augenkrankheiten beziehungsweise Tumoren des Sehapparates. *Arch. f. Ophth.*, 1924, *114*, 123–156.

72. Herrnheiser, Gustav, and Braun, Georg. Die Röntgenbehandlung der Augentuberkulose. *Strahlentherapie*, 1928, *28*, 770–778.
73. Herrnheiser, and Braun. Röntgentherapie der Augentuberkulose. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1928, *37*, 287.
74. Hessberg, R. Die Behandlung von Netzhautblutungen mit Röntgenstrahlen. *Strahlentherapie*, 1926, *23*, 313–317.
75. Himstedt, F., and Nagel, W. A. Über die Einwirkung der Becquerel- und der Röntgenstrahlen auf das Auge. *Ber. d. Naturforschergesell*, 1901, *11*, 139–152.
76. v. Hippel, E. Ueber eine neue biologische Wirkung der Röntgenstrahlen. *Deutsche med. Wchnschr.*, 1905, *31*, 2085–2086.
77. v. Hippel, E. Über angeborene Liddefekte bei neugeborenen Kaninchen nach Röntgenbestrahlung des trächtigen Muttertieres. *Ber. a. d. Ophth. Gesell.*, 1906, *33*, 293–295.
78. v. Hippel, E. Ueber experimentelle Erzeugung von angeborenen Star bei Kaninchen nebst Bemerkungen über gleichzeitig beobachteten Mikroophthalmus und Lidcolobom. *Arch. f. Ophth.*, 1907, *65*, 326–360.
79. v. Hippel, E. Ueber Versuche mit Strahlenbehandlung am Auge und den Lidern. *Arch. f. Ophth.*, 1918, *95*, 264–281.
80. Horner, W. D. A case of vernal conjunctivitis treated with radium. *U. S. Nav. Med. Bull.*, 1921, *15*, 128–130.
81. Horniker, E., and Romanin, V. Ueber einen Hülfsapparat zur Behandlung des Trachoms mit Röntgenstrahlen. *Ztschr. f. Augenh.*, 1905, *14*, 569–575.
82. Horvath, Bela. Röntgentherapeutische Erfahrungen in dem Gebiete der Augenheilkunde. *Magyar Röntgen-közlöny*, 1927, *1*, 366–370.
83. Hunter, E. L. The use of the X-ray in corneal ulcer. *J. Ophth. & Oto-Laryngol.*, 1920, *24*, 332–335.
84. Jacoby, F. Zur Radiumbehandlung des Trachoms. *Deutsche med. Wchnschr.*, 1906, *32*, 61–64.
85. Jacoby. Experimentelle Untersuchungen über Schädigungen des Auges durch Röntgenstrahlen. *Strahlentherapie*, 1923–1924, *16*, 492–506.
86. Jacqueau, Lemoine and Arcelin. Trachome et radiothérapie. *Lyon méd.*, 1920, *129*, 869–870.
87. Janeway, H. H. The therapeutic use of radium in diseases of the eye. *Arch. Ophth.*, 1920, *49*, 156–174; 238–243.
88. Japiot, P., and Bussy, L. La radiothérapie dans la kératite interstitielle. *J. radiol. et d'électrol.*, 1921, *5*, 106–112.
89. Japiot, P., and Bussy, L. La roentgenthérapie dans certaines affections inflammatoires de l'oeil. *Paris méd.* 1923, *47*, 126–128.
90. Javal and Curie. Französische Gesellschaften. *Wien. med. Wchnschr.*, 1902, *52*, 2055.
91. Jendralski, F. Radiotherapeutische Erfahrungen bei Tumoren und Tuberkulose des Auges und seiner Umgebung. *Klin. Monatsbl. f. Augenh.*, 1921, *65*, 565–573.
92. Jendralski. Ergebnisse der Röntgenbehandlung experimenteller Tuberkulose des vorderen Augenabschnittes. *Ber. a. d. Versamml. d. deutsch. ophth. Gesell.*, 1922, *43*, 71–73.
93. Jendralski, F. Strahlentherapie der Iriszysten. *Klin. Monatsbl. f. Augenh.*, 1922, *68*, 175–179.
94. Kardo-Sisoyeff, K. N. [Radium in various forms of trachoma.] *Russk. Vrach., St. Petersburg*, 1906, *10*, 605.
95. Kassabian, M. K. Quoted by Ring, G. P. Value of X-rays in ocular therapeutics. *J. Am. M. Ass.*, 1906, *47*, 994–1003.
96. Kempster, Christopher. The treatment of trichiasis by means of the X-rays. *Brit. M. J.*, 1915, *1*, 332.
97. King: Quoted by Sherer, J. W. Conjunctivitis from X-rays; incipient retinitis apparently due to the same cause; report of a case. *N. York State J. M.*, 1901, *74*, 543–545.
98. Koster, W. Über die direkte Behandlung von Augenerkrankungen mit Radium und Mesothorium. *Strahlentherapie*, 1913, *3*, 582–598; *Tr. Internat. Cong. Med.* 1913, Lond., 1914, Sect. ix, Ophthalmol., pt. 2, 241–245.
99. Koster, W., and Cath, I. G. Behandlung van oogziekten met radium. *Nederl. Tijdschr. v. Geneesk.*, 1911, *2*, 633–649; 702–734.
100. Kumer. Über die Radiumbehandlung einiger Liderkrankungen. *Ztschr. f. Augenh.*, 1923, *49*, 353–357.
101. Kumer, L., and Sallmann, L. Über die Radium-Therapie tuberkulöser Erkrankungen der Lider, der Bindehaut und des Tränensackes. *Ztschr. f. Augenh.*, 1924, *54*, 11–25.

102. Kümmell, R. Eigenartige Schädigung der Hornhaut durch Röntgenstrahlen. *Klin. Monatsbl. f. Augenh.*, 1921, *66*, 480–485.
103. Lane, Laura A. Radium in ophthalmology; with special reference to its use in benign affections. *J. Am. M. Ass.*, 1924, *83*, 1838–1945.
104. Lauber, H. Ueber die Behandlung oberflächlicher Hornhauterkrankungen mit Radium. *Wien. med. Wchnschr.*, 1921, *71*, 1066–1068.
105. Lawrence, H. Radium in the treatment of eye cases. *Intercolonial M. J. Australas*, 1909, *14*, 566–567.
106. Lawson, Arnold, and Davidson, J. M. Radium therapy in eye diseases. *Brit. M. J.*, 1910, *2*, 1491–1497.
107. Lindenfeld, B. Ein Beitrag zur Bildung rosettenartiger Figuren in der Netzhaut sonst normaler fötaler menschlicher Augen. *Klin. Monatsbl. f. Augenh.*, 1913, *15*, 440–451.
108. Linnell, E. H. Roentgen-ray flashes in the treatment of serious ocular affections. *Homeop. Eye, Ear & Throat J.*, 1909, *15*, 394–409.
109. Little, C. C., and Bagg, H. J. The occurrence of two heritable types of abnormality among the descendants of X-rayed mice. *Am. J. Roentgenol. & Rad. Therapy*, 1923, *10*, 975–989.
110. Lloyd. Le traitement de certains glaucomes par les rayons X. *Clin. opht.*, 1927, 546. Abstr. in: *Klin. Monatsbl. f. Augenh.*, 1927, *80*, 128–129.
111. London, E. S. Zur Lehre von den Becquerelstrahlen und ihren physiologisch-pathologischen Bedeutungen. *Berl. klin. Wchnschr.*, 1903, *40*, 523–524.
112. London, E. S. [Physio-pathological value of radium rays. I. Their relation to the domain of vision.] *Arch. biol., nauk.*, 1903, *10*, 191–211.
113. London, E. S. Action physiologique de la radioactivité très faible. *Arch. d'élect. méd.*, 1906, *14*, 94–101.
114. Loring, B. T. Effect of the X-ray flash upon blood pressure. *Homeop. Eye, Ear, & Throat J.*, 1910, *16*, 384–386.
115. Mackay, George. Illustration of spring catarrh under treatment by radium. *Tr. Ophth. Soc. U. Kingdom*, 1911, *31*, 217–218.
116. Marques, P. Lupus palpebral primitivo; radioterapia; curación. *Arch. de oftal. hispano-am.*, 1908, *8*, 333–334.
117. Martenstein, H., and Richter, A. Erfahrungen über die Behandlung der Iristuberkulose mit Röntgenstrahlen. *Klin. Monatsbl. f. Augenh.*, 1927, *78*, 643–650.
118. May, C. H. The treatment of trachoma with radium; the use of radium-coated celluloid plates for this purpose. *Ophthalmology*, 1912, *8*, 475–483.
119. Mayou, M. S. A case of trachoma treated by X-rays. *Tr. Ophth. Soc. U. Kingdom*, 1902, *22*, 95–96.
120. Mayou, M. S. The treatment of trachoma by the X-rays. *Tr. Ophth. Soc. U. Kingdom*, 1903, *23*, 10–23.
121. Mayou, M. S. The uses of the X-rays in ophthalmic surgery. *Arch. Roentg. Ray*, 1902–1903, *7*, 58–63.
122. Meisner, W. Radiumstrahlenwirkung im Kaninchenauge. *Ber. a. d. Ophth. Gesell.*, 1924, *44*, 172–174.
123. Meldolesi, G. Sulla terapia del tracoma con le radiazioni secondarie (secondo il metodo del Ghilarducci). *Actinoterapia*, 1924, *4*, 97–162.
124. Meldolesi, G., and Sabbadini, D. Sulla terapia del tracoma con le radiazioni secondarie ottenute col metodo del Ghilarducci. *Radiol. med.*, 1923, *10*, 222.
125. Milroy, T. H. The response of the developing retina to light and to radium emanations. *J. Physiol.*, 1905, *33*, 69–76.
126. Moore, R. F. Cataract from exposure to X-rays. *Lancet*, 1921, *1*, 137.
127. Müller, L., and Högler, F. Die Heilung des Trachoms durch Radiumstrahlen. *Wien. klin. Wchnschr.*, 1922, *35*, 954–955.
128. Mylius, K. Erfahrungen mit der Strahlenbehandlung tuberkuloser Erkrankungen des vordern Augenabschnittes. *Ztschr. f. Augenh.*, 1927, *61*, 230–241.
129. Neuschüler, A., and Steiner, R. Considerazioni sopra un caso di panno corneale grave da tracoma curato con il radium. *Gior. di elett. med.*, 1906, *7*, 251–263.
130. New, G. B., and Benedict, W. L. Radium in the treatment of the eye and adnexa. *Am. J. Ophth.*, 1920, *3*, 244–250.

131. Newcomet, W. S., and Krall, J. P. Quoted by Ring, G. O. Value of X-rays in ocular therapeutics. *J. Am. M. Ass.*, 1906, *47*, 994–1003.
132. Norton, A. B. Radium in eye diseases. *Homeop. Eye, Ear, & Throat J.*, 1905, *11*, 20–24.
133. Norton, A. B. The treatment of trachoma with radium rods; a new method. *Homeop. Eye, Ear, & Throat J.*, 1907, 3–8.
134. Pagenstecher, H. E. Strahlenwirkung auf das fötale Auge. Experimentelle Untersuchungen über die Entstechung der Netzhautrosetten. *Ber. ü. d. Versamml. d. Ophth. Gesell.*, 1916, *40*, 447–456.
135. Pardo, R. Due casi di tracoma trattati coi raggi di Röntgen. *Gazz. d. osp.*, 1904, *25*, 459–460.
136. Pardo, R. Dell'azione dei raggi di Röntgen sopra alcune affezioni oculari. *Arch. di ottal.*, 1904–1905, *12*, 288–328.
137. Peter, Gustav. Glaucom nach Röntgenbestrahlung. *Strahlentherapie*, 1924, *17*, 189–191.
138. Pissarello, C. L'azione del radium sui processi tubercolari della congiuntiva. *Ann. di ottal.*, 1915, *44*, 272–299.
139. Pordes, F. Über Röntgenbehandlung entzundlicher Erkrankungen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926–1927, *24*, 73–86.
140. Prokopenko, P. Treatment of trachoma by radium rays. *Vestnik. optalmol.*, 1910, *27*, 357–378.
141. Pusey, W. A. Tuberculosis of the mucous surface of the upper lid cured by radium. *J. Cutan. Dis.*, 1918, *36*, 242–243.
142. Pusey, W. A. Treatment of vernal conjunctivitis with radium. *J. Am. M. Ass.*, 1918, *71*, 806–807.
143. Rados, A., and Schinz, H. R. Tierexperimentelle Untersuchungen über die Röntgenempfindlichkeit der einzelnen Tiele des Auges. *Arch. f. Ophth.*, 1922, *110*, 354–369.
144. Rauch, R. Über die Anwendung von X-strahlen gewisser Intensität auf das Auge. *Strahlentherapie*, 1914, *4*, 471–488.
145. Richter. Röntgenbehandlung der tuberkulösen Iridozyklitis. *Klin. Monatsbl. f. Augenh.*, 1927, *78*, 91.
146. Rollet, and Bussy. Iritis nodulaire probablement tuberculeuse. Radiothérapie. Guérison. *Lyon méd.*, 1920, *129*, 457–458.
147. Rollet, and Bussy. Conjunctivite granuleuse grave. Radiothérapie. Amélioration. *Lyon méd.*, 1920, *129*, 458.
148. Rollet, and Malot. Rayons X et l'oeil normal. *Rev. gén. d'opht.*, 1914, *33*, 313–317.
149. Röntgen, W. C. Über eine neue Art von Strahlen. *Sitzungsh. d. phys.-med. Gesellsh. zu Würzb.*, 1895, 132–141.
150. Röntgen, W. C. Weitere Beobachtungen über die Eigenschaften der X-strahlen. *Sitzungsb. d. K. preuss. Akad. d. Wissensch.*, 1897.
151. Roselli, R. L'azione del radium sui tessuti oculari. *Ann. di ottal.*, 1907, *36*, 914.
152. Sabbadini, D. Sulla terapia del tracoma con le radiazioni secondarie; risultati clinici. *Arch. di ottal.*, 1924, *31*, 341–356.
153. Sabbadini, D. La terapia sperimentale delle ulcere corneali microbiche colle radiazioni secondarie. *Arch. di ottal.*, 1924, *31*, 356–365.
154. Sabbadini, D. Le modificazioni cliniche ed anatomopatologiche della congiuntiva tracomatosa in seguito all'azione delle radiazioni secondarie. *Arch. di radiol.*, 1926, *2*, 584–688.
155. Sabbadini, Dario. Lesioni da raggi X nell'occhio umanc *Arch. di radiol.*, 1926, *2*, 795–826. Abstr. in: *Internat. Radiotherapie*, 1927, *2*, 653–654.
156. Sallman. Zur Radiumbehandlung des Trachoms. *Ztschr. f. Augenh.*, 1923, *49*, 357–361.
157. Scheerer, Richard. Röntgenbestrahlung beim Uvealtuberkulose. *Klin. Monatsbl. f. Augenh.*, 1925, *75*, 27–61.
158. Schnaudigel, O. Zur Radiumbehandlung der Conjunctivitis vernalis. *Klin. Monatsbl. f. Augenh.*, 1912, *2*, 620–623.
159. Scholtz, W. Über den Einfluss der Röntgenstrahlen auf die Haut in gesundem und krankem Zustande. *Arch. f. Dermat. u. Syph.*, 1902, *59*, 87–104; 241–260; 421–446.
160. Sgrosso, S. Contributo alla radioterapia delle affezioni oculari. *Arch. di ottal.*, 1922, *29*, 305–319.
161. Sherer, J. W. Conjunctivitis from X-rays; incipient retinitis apparently due to the same cause; report of a case. *N. York M. J.*, 1901, *74*, 543–545.

162. Shumway, E. A. Vernal conjunctivitis greatly improved by radium treatment. *Tr. Coll. Phys.* Philadelphia, 1918, *40*, 225–226.
163. Stargardt, K. Über die Wirkung der Röntgenstrahlen auf den Trachomfollikel. *Ztschr. f. Augenh.*, 1905, *14*, 251–258.
164. Stargardt, K. Die Röntgentherapie in der Augenheilkunde; die Röntgenbehandlung des Trachoms. *Strahlentherapie*, 1912, *1*, 526–539.
165. Stargardt, K. Versuche mit Thorium X am Auge. *Ztschr. f. Augenh.*, 1915, *34*, 195–207.
166. Stephenson, S. Tuberculosis of the conjunctiva cured by X-rays. *Brit. M. J.*, 1903, *1*, 1313–1314.
167. Stephenson, S., and Walsh, B. On the curative treatment of trachoma by X-ray tube exposure and by high-frequency current. *Med. Press & Circular*, 1903, *75*, 155–157. Abstr. in: *Lancet*, 1903, *1*, 237.
168. Sternberg, J. E. Intermittent Roentgen ray in primary atrophy. *Homeop. Eye, Ear & Throat J.*, 1910, *16*, 387–388.
169. Stock. Ueber Behandlung der chronischen tuberkulösen Iridozyklitis mit Röntgenstrahlen. *München. med. Wchnschr.*, 1925, *72*, 1499–1500.
170. Stock, W. Strahlenbehandlung in der Augenheilkunde. *Klin. Monatsbl. f. Augenh.*, 1926, *76*, 542–560.
171. Takahashi, T. Klinische und experimentelle Erfahrungen mit der Radiumbehandlung bei malignen Tumoren und Tuberkulose auf ophthalmologischen Gebiet. *Tohoku J. Exper. Med.*, 1924, *5*, 385–404.
172. Terrien, F. Radio-diagnostic et radiothérapie en ophtalmologie. *Arch. d'opht.*, 1919, *36*, 513–539.
173. Terrien, F. Les rayons X et leurs propriétés principales. *Bull. et mém. Soc. d'opht.*, 1919, *32*, 1–118.
174. Terrien, F., and Clunet. Quoted by Terrien, F. and Ledoux-Lebard, R.
175. Terrien, F., and Ledoux-Lebard, R. Emploi du radium et des rayons X en ophtalmologie. *Ann. d'ocul.*, 1919, *156*, 364–368.
176. Thiébault. Notes et observations sur l'emploi du radium (épithéliomes, sclérites, trachome). *Clin. opht.*, 1906, *12*, 347–357.
177. Thielemann, R. Zur Wirkungsweise des Radiumbestrahlung auf die trachomatöse Bindehaut. *Ztschr. f. Augenh.*, 1905, *14*, 559–569.
178. Tribondeau, L., and Belley, G. Cataracte expérimentale obtenue par roentgénisation de l'oeil d'animaux nouveau-nés. *Compt. rend. Soc. de biol.*, 1907, *63*, 126–128.
179. Tribondeau, L., and Belley, G. Microphtalmie et modifications concomitantes de la rétine par roentgénisation de l'oeil d'animaux nouveau-nés. *Compt. rend. Soc. de biol.*, 1907, *63*, 128–130.
180. Tribondeau, L., and Lafargue, P. Action différente des rayons X sur le cristallin des animaux jeunes et des animaux adultes. *Compt. rend. Soc. de biol.*, 1907, *63*, 716–717.
181. Tribondeau, L., and Lafargue, P. Étude expérimentale de l'action des rayons x sur la rétine et le nerf optique. *Compt. rend. Soc. de biol.*, 1908, *65*, 149–151.
182. Tribondeau, L., and Lafargue, P. Présentation d'un chat dont les yeux ont été roentgénisés. *Compt. rend. Soc. de biol.*, 1908, *65*, 447.
183. Tribondeau, L., and Récamier: Altérations des yeux et du squelette facial d'un chat nouveau-né par roentgénisation. *Compt. rend. Soc. de biol.*, 1905, *58*, 1031–1032.
184. Uthoff. Quoted by Darier, A. Die Anwendung des Radiums in der Augentherapie. *Ber. ü. d. Versamml. Ophth. Gesellsch.*, 1906, 205–215.
185. Van Duyse. Prolifération lymphomateuse hyaline de la conjunctive bulbaire droite; guérison par les rayons X; considérations sur quelques pseudoplasmes de la conjunctive. *Arch. d'opht.*, 1905, *25*, 402–421.
186. Vasyutinski, A. G. [Radiotherapy for trachoma.] *Russk. Vrach.*, 1905, *4*, 12–16.
187. de la Vega, E. Los rayos X en el tratamiento de las queratitis intersticiales. *Bol. Inst. de med. exper. para. el estud. y. trat. del cancer*, 1924, *1*, 265–272.
188. Vigano, Emilio. Dacriocistite e radioterapia. *Atti d. Cong. ital. d. radiol. med.*, 1913, *1*, 233–236.
189. Vigano, E. I. Vantaggi della radioterapia nelle lesioni oculari consecutive a ferite e nei distacchi di retina. *Radiol. med.*, 1920, *7*, 223–229.
190. Wassing, Hans. Über Radiumbehandlung bei Trachom. *Ztschr. f. Augenh.*, 1923, *49*, 361–363.
191. Wassing, Hans. Beitrag zur Strahlenbehandlung tuberkulöser Augenerkrankungen. *Klin. Monatsbl. f. Augenh.*, 1924, *72*, 175–181.

Journal Page 940

192. Wells, D. W. Experience with the Roentgen ray flash in ocular disease. *Homeop. Eye, Ear, & Throat J.*, 1910, *16*, 377–383.
193. Wetterstrand, G. A. Zur Kenntnis der Röntgentherapie bei Augentuberkulose. *Acta radiol.*, 1926, *7*, 639–645.
194. Wilkinson, O. Cataract probably due to X-ray exposure. *Am. J. Ophth.*, 1920, *3*, 435–436.
195. Williams, C. H. A severe case of uveitis treated with radium. *Tr. Am. Ophth. Soc.*, 1904, *10*, 269–275.
196. Williams, F. H. Notes on radium: production of the gamma rays from the beta rays of radium; use of radium in some diseases of the eye. *Boston M. & S. J.*, 1904, *150*, 559–561.
197. Withers, Sanford. Value of radiation therapy in ophthalmology. *Am. J. Ophth.*, 1924, *7*, 514–521.
198. Zelenkovsky, J. W. Heilung des Trachoms mittelst Radium. *Neue Therap;* 1905, *3*, 250–252.
199. Zelenkovsky, J. V. Recherches sur la valeur de la radiumthérapie du trachome à la période granuleuse. *Arch. d'élect. méd.*, 1906, *14*, 695–696.
200. Zelenkovsky, J. V. [Becquerel's rays (radium) in the treatment of diseases of the eye; treatment of trachoma (granular period).] *Russk. Vrach.*, 1906, *5*, 189; 224; 264. Abst. in: *Arch. d'élect. méd.*, 1906, *14*, 759–760.
201. Zelenkovsky, J. W. Zur Frage über die Heilung des Trachoms durch Becquerelstrahlen (Radium). *Arch. f. Augenh.*, 1908, *60*, 63–92.
202. Zentmayer. Quoted by Ring, G. O. The value of X-rays in ocular therapeutics. *J. Am. M. Ass.*, 1906, *47*, 994–1003.

BIBLIOGRAPHY FOR EAR

1. Albrecht, W. Ueber Radiumbehandlung bei Schwerhörigen. *Beitr. z. Anat. Physiol. Path. u. Therap. d. Ohres*, 1913–1914, *7*, 413–422.
2. Barwell, Howard. X-ray treatment of otosclerosis. *Lancet*, 1921, *2*, 728.
3. Beattie, R. Treatment of subacute and chronic otitis media with the use of the X-ray. *J. Michigan State M. Soc.*, 1921, *20*, 449–451.
4. Beck, J. C. Experiments with radium in some nose, throat, and ear diseases. *Chicago Med. Recorder*, 1904, *26*, 757–775.
5. Bondy, I. G. Geheilte Mittelohrtuberkulose. *Monatsch. f. Ohrenh.*, 1927, *62*, 237.
6. Boonacker. Discussion. *Nederl. Tijdschr. v. Geneesk.*, 1914, *58*, 2079–2083; 1915, *59*, 1841–1842.
7. Bryant, W. S. Notes on the use of radium in treatment of diseases of the ear. Abstr. in: *Med. Rec.*, 1914, *86*, 376.
8. Burger, H. Nadeelig gevolg van radium-behandeling bij hardhoorendheide. *Nederl. Tijdschr. v. Geneesk.*, 1916, *1*, 229–232.
9. Cemach, A. I. Die Probleme der Röntgentherapie der Mittelohrtuberkulose. *Ztschr. f. Hals-, Nasen-, u. Ohrenh.*, 1922, *3*, 285–294.
10. Chilow, K. L. Über die Anwendung von Radiumemanation in der experimentellen Labyrinthologie. *Monatschr. f. Ohrenh.*, 1927, *61*, 786–794.
11. Denman, I. O. The rôle of irradiation in focal infections and obstructive deafness. *J. Ophth., Otol. & Laryngol.*, 1925, *29*, 409–417.
12. Di Donato, D. Della roentgenterapia nelle otorree. *Arch. ital. di otol.*, 1926, *37*, 335–337.
13. Dionisio, J. Traitement de l'otite moyenne suppurée chronique par les rayons X. *Arch. d'élect. méd.*, 1906, *14*, 934.
14. Dreyfuss, R. Erfahrungen über Radium bei Ohraffektionen. *Strassburger med. Ztschr.*, 1914, *11*, 23–24.
15. Ewald. Die Wirkung des Radiums auf das Labyrinth. *Zentralbl. f. Physiol.*, 1905, *19*, 297–298.
16. Forschner, L. Röntgenbehandlung des Othämatoms. *Monatschr. f. Ohrenh.*, 1924, *58*, 760–762.
17. Forschner, L. In Frey, V. H. Ein Fall von operativ geheilten Othämatom nach der von mir schon früher beschriebenen Methode. *Monatschr. f. Ohrenh.*, 1924, *58*, 284–285.
18. Forschner, L. Akute Perichondritis, Röntgenbehandlung. *Monatschr. f. Ohrenh.*, 1926, *60*, 1208.
19. Forschner, L., and Regnier, E. Die Röntgentherapie des Othämatoms. *Strahlentherapie*, 1925, *21*, 91–95.
20. Frey, E., and Kriser, A. Therapeutische Versuche mit Röntgenbehandlung bei Otosklerose. *Ztschr. f. Hals-, Nasen-, u. Ohrenh.*, 1923, *6*, 334–340.

21. Grande, C. La cura delle otiti medie catarrali coi raggi Roentgen. *Arch. ital. di otol.*, 1925, *36*, 197–205.
22. Haenlein, Oskar. Radium und Mesothorium bei Schwerhörigkeit und ohrensausen. *Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres*, 1913–1914, *7*, 423–449.
23. Jarvis, D. C. The effect of small doses of roentgen rays in certain forms of impaired hearing. *Am. J. Roentgenol. & Rad. Therapy*, 1923, *10*, 201–202.
24. Jaulin. Traitement de l'otite scléreuse par les rayons X. *Arch. d'élect. méd.*, 1908, *16*, 92–97.
25. Kinney, L. C. The roentgen therapy of tinnitus aurium. *Am. J. Roentgenol. & Rad. Therapy*, 1923, *10*, 378–379.
26. Kriser. A. Die Behandlung der Otosklerose mit Röntgenstrahlen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, *33*, 86–88.
27. Lake, R. A case of early otosclerosis treated with radium. *Tr. Internat. Otol. Cong.*, 1912, *9*, 545–551.
28. Lüdin, M. Die Röntgentherapie in der inneren Medizin. *Schweiz. med. Wchnschr.*, 1921, *51*, 1081–1084.
29. Marx, Hermann. Untersuchungen über experimentelle Schädigungen des Gehörorgans. B. Über Schädigungen des Gehörorganes durch Strahlenwirkung. *Ztschr. f. Ohrenh.*, 1909, *59*, 192–210.
30. McCoy, John. Treatment of defective hearing by small doses of X-rays. *Am. J. Roentgenol. & Rad. Therapy*, 1923, *10*, 203.
31. McCulloch, H. D. Four cases of extreme deafness (labyrinthine) showing improvement by treatment with the ultra X-rays. *Lancet*, 1913, *2*, 223.
32. Meyjes, W. P Doofheid behandeld met mesothorium. *Nederl. Tijdschr. v. Geneesk.*, 1914, *2*, 2079–2083.
33. Miller, Frank. Discussion of communications on relation of endocrine system to deafness. *Laryngoscope*, 1921, *31*, 740–741.
34. Ortleff, Hans. Über therapeutische Versuche mit Röntgenstrahlen bei der Otosklerose. *Arch. f. Ohrenh.*, 1913, *90*, 233–244.
35. Passow, A. Neue Mittel gegen Hörstörungen und Ohrgeräusche. *Med. Klin.*, 1914, *10*, 753–755.
36. Raynal, A. Quelques essais de radiothérapie dans les affections chroniques de l'oreille moyenne et de l'oreille interne. *J. radiol. et d'électrol.*, 1923, *7*, 180–181.
37. Regnier. Othaematom. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1923, *31*, 790.
38. Révész, V., and Kövari. Die Röntgentherapie der Otosklerose. *Gyógyászat*, 1926, 28. Abstr. in: *Internat. Radiotherap.*, 1926–1927, *2*, 638–639.
39. Schwarz, Gottwald. Die Röntgenstrahlen im Dienste der Ohrenheilkunde. *Monatschr. f. Ohrenh.*, 1910, *44*, 675–683.
40. Sobotky, I. Radium treatment of tinnitus and middle-ear deafness. *N. York Med. J.*, 1917, *105*, 1138–1139.
41. Stein, S. X-ray treatment in deafness and tinnitus. *Bull. Oto-Laryngol. Clin.*, 1924, 43–45.
42. Stokes, C. F. Discussion of communications on relation of endocrine system to deafness. *Laryngoscope*, 1921, *31*, 739–740.
43. Szasz. Die Behandlung der chronischen Tubeneiterung mit Röntgenstrahlen. *Ztschr. f. Hals-, Nasen-, u. Ohrenh.*, 1922, *3*, 95–98.
44. Thielemann. Experimentelle Röntgenschädigungen des Ohres. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1928, *37*, 563–564.
45. Thost, Arthur. Die Behandlung von Erkrankungen der obern Luftwege und der Ohren mit Röntgenstrahlen. *Monatschr. f. Ohrenh.*, 1914, *48*, 84–106.
46. Turano, L. Il trattamento delle otiti medie croniche purulente con le radiazioni secondarie. Atti del VI Congresso italiano di Radiologia Medica. 360. Abstr. in: *Internat. Radiotherap.*, 1926–1927, *2*, 639–640.
47. Urbantschitsch, Victor. 22. Versamml. d. Deutsch. Otol. Gesellsch. zu Stuttgart. *Arch. f. Ohrenh.*, 1912, *91*, 245.
48. Urbantschitsch, Victor. Über einige mit Radium behandelte Ohrenfälle. *Arch. f. Ohrenh.*, 1915, *96*, 15–21.
49. Webster, J. H. D. X-ray treatment of 2 cases of otosclerosis. *Arch. Radiol. & Electrotherap.*, 1921, *26*, 69–75.
50. Yocom, A. L., Jr. X-ray treatment of chronic otitis media. *Med. Herald*, 1925, 44, 268–269.

SUBJECT INDEX TO VOLUME XXVI

(abs) = Abstract (E) = Editorial

Abortion, roentgen, further experience (abs), 325
therapeutic, technique and indications of, by roentgen rays (abs), 331
Abscess, paravertebral, an early roentgen sign of tuberculous spondylitis (abs), 127
subphrenic amebic (abs), 489
Acromegaly with adiposo-genital syndrome and glycosuria of syphilitic origin (abs), 299
Actinomycosis of the thorax (abs), 483
Adeno-epitheliomas of uterus, results of radiotherapy (abs), 132
Adenopapillomata, multiple, of stomach (abs), 920
Adnexa, tuberculosis, roentgen therapy (abs), 332
Agranulocytosis, roentgen therapy (abs), 329
Alimentary canal and Alimentary tract: See Gastrointestinal tract
American College of Physicians, announcement of meeting, 770
American College of Radiology, Third International Conference, 621
American Journal of Roentgenology and Radium Therapy, relation of, to development of radiology, 523
twenty-fifth anniversary (E), 616
American Quarterly of Roentgenology, frontispiece opposite page 511
American Radium Society, officers elected, 476
American Roentgen Ray Society, annual meeting (E), 277; (E), 616
commercial exhibit, 624
preliminary program, 1931 meeting, 286
scientific exhibit, 622
Aneurysm of ischiatic artery (abs), 319
Aneurysmography by means of iodated urea (abs), 319
Annular shadows, localized pneumothoraces as cause of, in roentgenograms of chest (abs), 916
Anomalies in topography of the alimentary tract, 223
Anomaly of scapular girdle (abs), 312
Aorta, descending, visible to roentgen rays, should it be considered pathologic? (abs), 303
stenosis of, with calcification of the cusps (E), 468
Apparatus, roentgen, progress in development, 517
simple, for purifying radon, 630
Appendicitis, chronic, roentgen diagnosis (abs), 306
Appendix and cecum, position of, during pregnancy (abs), 306
Arteries and veins in living, new method of roentgenography (abs), 131
Arteriography (E), 103; (abs), 131
Arthritis: See also Polyarthritis and Spondylarthritis
concept of (abs), 317
Arthrosis (abs), 317
Asbestosis bodies in sputum and lung (abs), 301
pulmonary (abs), 483
Aspergillosis, primary, of the lungs (abs), 916
Atelectasis: See Lungs, collapse
Atlantic City, this year's meeting place, 284
Atlas, knowledge of spina bifida of (abs), 634
Atresia, congenital intestinal (abs), 488
congenital, of esophagus, 894
Auricle, left, extreme dilatation of, 66
Austria, development of roentgenology in (abs), 776

Berven, Elis G. E. (E), 472
Biological dosage unit for roentgen rays (abs), 778
Blood pressure variations after roentgen irradiation and clinical significance (abs), 775
Bone, primary and metastatic tumors of, changes in, following various doses of roentgen rays (abs), 326
repair of, in presence of aseptic necrosis resulting from fractures, transplantations and vascular obstruction (abs), 782
tuberculosis, healing (abs), 315
Bones, changes in, in case of chronic empyema (abs), 313
echinococcus involvement (abs), 311
Book Reviews
Deep X-Ray Therapy in Malignant Disease. By Walter M. Levitt, 111
Dental Roentgenology. By LeRoy M. Ennis, 112
The Diagnosis and Treatment of Brain Tumors. By Ernest Sachs, 477
Roentgen Interpretation. By George W. Holmes and Howard E. Ruggles, 477
Einführung in die Röntgentherapie chirurgischer Erkrankungen. By Josef Palugyay, 478
Practical X-Ray Treatment. By Arthur W. Erskine, 478
Verlauf der wichtigsten Knochen- und Gelenkerkrankungen im Röntgenbilde. By Victor Hoffmann, 626
Ergebnisse der medizinischen Strahlenforschung (Röntgendiagnostik, Röntgen-, Radium- und Lichttherapie). Edited by H. Holfelder, H. Holthusen, O. Jüngling, H. Martius, and H. R. Schinz, 627
Die normale Entwicklung des Knochensystems im Röntgenbild. By E. Ruckensteiner, 771
Diagnosis in Joint Disease. By Nathaniel Allison and Ralph K. Ghormley, 771
Cutaneous X-Ray and Radium Therapy. By Henry H. Hazen, 772
Brain, pneumoventriculography in two cases of disease of (abs), 299

tumors, roentgenography in, 414
BREAST, cancer, use of radium and roentgen rays in conjunction with radical operation (abs), 328
carcinoma, five-year end-results (abs), 320
carcinoma, radiological treatment (abs), 320

CALCIFICATION, intracranial, with particular reference to that occurring in gliomas (abs), 915
of falx cerebri (abs), 298
thoracic, recognition of, 191
CALCIUM, blood serum, in relation to healing of fractures (abs), 636
CANALIS EGESTORIUS, typical arrangement of folds of (abs), 485
usefulness and use, as a symptom, of transverse folds of (abs), 485
CANCER: See also Carcinoma; Malignancy, etc.
advanced, clinical evaluation of various qualities of roentgen and radium rays for treatment of, 729
how we can meet problem of, 726
intraoral, treatment of metastatic involvement of neck secondary to, 20
intraoral, use of gold filtered radon implants in treatment, 28
is irritation a cause of, 456
new lead preparation for treatment of (abs), 323
of breast, use of radium and roentgen rays in conjunction with radical operation (abs), 328
of cervix, radiation therapy of, at Bellevue Hospital, 746
of mouth and pharynx (abs), 320
of mouth, radium and roentgen treatment, 12
of stomach, gastric retention and dilatation of stomach in (abs), 306
of tongue, radium and surgery in (abs), 136
of tongue, radium treatment (abs), 137
oral, treatment, 5
patients, diet (abs), 786
CANNON, WALTER B., anniversary (E), 767
CAPILLARIES, changes in, on roentgen irradiation (abs), 141
CARCINOMA, adenoid cystic (abs), 309
buccal, principles and results in radium treatment (abs), 136
early recognition of, and gastric ulcer, as revealed by roentgen ray (abs), 123
intraoral, structure of, in relation to radiosensitivity, tissue dosage and adequate therapy, 1
of breast, five-year end-results (abs), 320
of breast, radiological treatment (abs), 320
of cervix, technique of treatment, 734
of fundus of uterus, radium as an adjunct to surgery in treatment, 738
of lung, with multiple cavities of bronchiectatic type (abs), 917
of skin, results of treatment in 152 cases, 881
of thyroid, skeletal metastasis in (abs), 310
of uterus, bacterial flora in, after treatment with radium (abs), 322
therapy of, with superimposed (fractional) roentgen irradiation (abs), 325
CARDIOVASCULAR affections, radiotherapy of sympathetic in (abs), 134
CASTRATION, temporary roentgen, development of children born after (abs), 785
temporary roentgen, in treatment of endometrioid tumors of ovary and peritoneum (abs), 333
temporary roentgen, indications and results (abs), 330
CATHODE RAYS, physics and technique of (abs), 779
CECUM, undescended, 839
CHEMISTRY, inorganic blood, in the osteochondritides (abs), 127
CHEST, localized pneumothoraces as cause of annular shadows in roentgenograms of (abs), 916
CHOLECYSTOGRAPHY: See also Gall-bladder
comparison of oral and intravenous methods, 232
intravenous, simple technique, 912
rhythm of elimination through the liver of the tetraiodophenolphthalein (abs), 307
visualization of biliary vesicle by (abs), 125
CHONDRODYSPLASIA, unilateral (Ollier's disease), 428
COLITIS, relation of, to polyposis of the intestine, 834
COLON, diagnosis of precancerous lesions of (E), 766
roentgen-anatomic studies of, in 600 patients with pulmonary tuberculosis, 704
CORACO-CLAVICULAR JOINT, genesis and clinical importance of (abs), 492
CORSON, EUGENE ROLLIN, a pioneer roentgenologist, 759
portrait opposite page 761
COUTARD, HENRI (E), 471
COUTARD'S protracted fractional roentgen irradiation, experience with (abs), 333
CYST, calcified hematic, of pleura (abs), 303
hydatid, of lung (abs), 303
hydatid, of lung, pyopneumothorac secondary to (abs), 120

DACRYOCYSTITIS, tuberculous, case of, treated with roentgen rays, 264
DEATH, roentgen examination as means of diagnosing (abs), 141
DENTAL roentgenographic shadows, evaluation (abs), 915
roentgenology, most common applications (abs), 300
DERMATOLOGY, sources of danger in roentgen therapy in (abs), 327
DEVELOPER, method of testing (abs), 141
DIAPHRAGM, absence of half of, 899
graphic method of recording its respiratory excursion (abs), 878
DIVERTICULA of stomach (abs), 305

Dosimetry in radium therapy (abs), 775
Duodenum, bulb, roentgen demonstration of varices of (abs), 487
gallstone obstruction of, 92
mobile (abs), 124
Dwarfism, dyschondro-osteosis as a new variety of (abs), 128
Dyschondro-osteosis, a new variety of dwarfism (abs), 128
Dysostosis, cleidocranial, 710
lacunar hypophyseal (abs), 300

Ear, action of roentgen rays and radium on, 787, 919
Echinococcus involvement of bones (abs), 311
Effect, biological, of roentgen rays, relation of quantum energy to (abs), 143
of roentgen and ultraviolet rays on skin capillaries (abs), 319
of roentgen rays and radium on eye and ear, 639, 787, 919
of roentgen rays and radium upon gastrointestinal tract, 145, 335, 493
of roentgen rays on ovary during period of ovogenesis, histological study (abs), 144
of x-rays on glutathione content and oxygen consumption of normal and regenerating planarians (abs), 781
Electron physics, contributions of a quarter century of, to roentgen-ray science, 528
Emphysema, mechanism of physical signs in neoplastic and other diseases of lung (abs), 303
Empyema, chronic changes in bones in a case of (abs), 313
of the new-born (abs), 483
Endometriosis, rectovaginal, treated successfully with roentgen rays (abs), 333
Endothelioma of tibia, case of (abs), 491
Epiphyses, and short bones, streptococcal infections (abs), 315
unusual manifestations of pathology of, in newborn infant, 868
Epithelioma, cutaneous, 1302 cases treated at Institute of Radiology, University of Montevideo (abs), 319
Epitheliomas of uterine cervix, study of microbic flora of (abs), 132
Epituberculosis (abs), 119
Esophagus, action of roentgen rays and radium on, 166
congenital atresia, 894
peptic ulcer of, 696
pharmaco-dynamic modifications of normal and neoplastic (abs), 919
rare malignant growths of, roentgen diagnosis (abs), 300
Eye, action of roentgen rays and radium on, 643, 787, 919

Falx cerebri, calcifications of (abs), 298
Fibrocartilaginous nodule of posterior surface of intervertebral discs (abs), 316
Fluorescent chalk and illuminator for roentgenograms for roentgenoscopic dark room, 629
Foot, case of malformation of (abs), 318
Foreign bodies, intraocular magnetic, study of (abs), 117
Fractures, blood serum calcium in relation to healing of (abs), 636
of the os calcis, diagnosis, pathology and treatment (abs), 635
Frontal region, case of intracranial, post-traumatic pneumatocele of (abs), 299

Gall-bladder: See also Cholecystography
effective stimulant for, to supplant fat meal, 904
study of contractions, 87
Gallstone obstruction of duodenum, 92
Ganglionectomy, sympathetic, evidence shown in roentgenograms of changes in vascular tree following experimental (abs), 319
Gastritis, hypertrophic, roentgen diagnosis (abs), 306
Gastrointestinal tract, action of roentgen rays and radium on, 145, 335, 493
anomalies in topography, 223
comparative x-ray study of passage of foodstuffs through, in rats (abs), 779
fluoroscopic study of motility of, in rats fed a vitamin deficient diet (abs), 780
progress in roentgenologic examination of (E), 907
respective indications of roentgenoscopy and roentgenography in diseases of (abs), 307
Genitalia, female, roentgen stimulant irradiation of subacute and chronic inflammation of (abs), 332
Gliomas, calcification in (abs), 915
Glutathione content and oxygen consumption of normal and regenerating planarians, action of x-rays on (abs), 781
Goiter, size of heart in (abs), 123
Gonorrhea in the male, roentgen treatment (abs), 324
Grenz-ray tubes, calibration of (abs), 778
Grid diaphragm applied to stereographic study of mastoids, 107
Gynecology, development of roentgen treatment in, during last ten years at Second University Gynecological Clinic at Budapest (abs), 638
present status of radiotherapy in (abs), 323
radiation therapy in (abs), 321

Haenisch, George Fedor (E), 469
Hallux valgus, roentgen appearance of first tarsometatarsal articulation in (abs), 635
Heart, and great vessels, technical point of teleroentgenography of (abs), 786
does there exist a hypertrophy of, caused by work? (abs), 304
orthoroentgenography of (abs), 304
pulsation of, in pneumothorax (abs), 484

size of, in goiter (abs), 123
study of right margin of, and vessels (abs), 484
HEMATOPOIETIC SYSTEM, roentgen treatment in diseases of (abs), 138
HERNIA, diaphragmatic, 899
of mediastinum (abs), 120
HICKEY, PRESTON M., memorial to, 770
HIP JOINT, case of osteitis fibrosa cystica in region of (abs), 491
HIRSUTISM, infantile, a case of, treated by radiotherapy (abs), 135
HISTORY of evolution of roentgen-ray plates and films, 540
HOLZKNECHT, GUIDO, announcement of death (E), 767
HYDROPS TUBAE PROFLUENS, diagnosis and treatment by salpingography (abs), 331
HYPOPHYSO-THALMIC region, roentgen irradiation of (abs), 133

INFLAMMATION, subacute and chronic of female genitalia, roentgen stimulant irradition (abs), 332
INTENSIFYING SCREEN in lung exposures (abs), 141
INTENSITY of gamma radiation at surface and immediately around radium needles (abs), 322
INTERLOBAR FISSURES, anatomy (abs), 915
INTERNATIONAL CONGRESS OF RADIOLOGY, Third, report of, 620
INTERVERTEBRAL DISCS, fibrocartilaginous nodule of posterior surface of (abs), 316
INTESTINE, action of roentgen rays and radium on, 337
congenital atresia of (abs), 488
relation of colitis to polyposis of, 834
small, case of hepato-diaphragmatic interposition of loops of (abs), 306
IODIZED OIL in diagnosis of nasal sinus conditions (abs), 300
IRIS, two cases of miliary tuberculosis of, cured by radiotherapy (abs), 320
ISAMIN-BLUE, experience with, combined with radiotherapy (abs), 637

JOINTS, chronic rheumatism, grand syndromes (abs), 317
unusual manifestations of pathology of, in newborn infant, 868

KASCHIN-BECK'S DISEASE (abs), 491
KERATODERMIA treated by irradiation of cutaneous sympathetic (abs), 136
KIDNEY, modifications of the rhythm of evacuation of pelvis of, in the pyelonephrites (abs), 126
KIENBÖCK'S DISEASE (abs), 312

LARYNX, diagnosis of disease of (abs), 301
roentgen findings in tuberculosis of (abs), 301
LEAD, a new preparation of, in treatment of cancer (abs), 323
equivalence, experimental measurements of, in various building materials (abs), 784
protective, thicknesses of, in German radiation protection rules (abs), 784
LEUCEMIA, chronic, roentgen treatment, 47
myeloid, irradiation (abs), 330
LICHEN PLANUS, case of, cured by roentgen irradiation of sympathetic (abs), 135
LIPOMA, periosteal (abs), 130
LUES: See Syphilis
LUNG, postpneumonic, 371
pyopneumothorax secondary to hydatid cyst of (abs), 120
site of predilection in cross-infection from right to the left (abs), 302
tissue, determination of radiation values in, with variable qualities of radiation (abs), 321
LUNGS, anatomy of interlobar fissures (abs), 915
asbestosis bodies in (abs), 301
asbestosis of (abs), 483
carcinoma, with multiple cavities of bronchiectatic type (abs), 917
clinical and roentgen study of tuberculous lobitis (abs), 482
collapse, mechanism of physical signs in neoplastic and other diseases of (abs), 303
collapse, further studies in obstructive (abs), 781
course of tuberculosis in (abs), 118
hydatid cyst (abs), 303
intensifying screen in exposures of (abs), 141
interstitial lues of (abs), 302
massive collapse, further study (abs), 916
primary aspergillosis of (abs), 916
roentgen examination of, in conscripts and recruits in Swiss army (abs), 302
yeast infection, 408
LYMPHOBLASTOMA, intrathoracic, roentgen study, 681
LYMPHOMAS, primary malignant, roentgen therapy of (abs), 329

MALACIA of semilunar bone (abs), 312
MALIGNANCY, superficial, treatment of, 461
MALIGNANT growths of esophagus, rare, roentgen diagnosis, 300
lesions of mouth, treatment by contact applications of radium, 23
MASTOIDS, grid diaphragm applied to stereographic study of, 107
roentgen examination (abs), 300
MEASUREMENT of radium therapy at the surface (abs), 328
ultraviolet, with cadmium photo-electric cell, 272
MEASUREMENTS, experimental, of lead-equivalence of various building materials (abs), 784
MEASURING and recording roentgen tube currents and voltages, method of, 871
MEDIASTINUM, hernia of (abs), 120
teratoma, in an infant (abs), 918

Melanoma, malignant, six cases treated with x-radiation (abs), 321
malignant, treatment, 236
Metalix tubes, Müller, Philips type of, investigation of characteristics, as revealed by the roentgenogram (abs), 777
Metastasis, skeletal, in carcinoma of thyroid (abs), 310
Metropathy, hemorrhagic, treatment at Würzburg University Gynecological Clinic from 1923 to 1928 (abs), 331
Minnesota Radiological Society, meeting of, 770
Moles, pigmented, treatment, 236
Mouth, cancer of (abs), 320
cancer, radium and roentgen treatment, 12
treatment of malignant lesions of, by contact applications of radium, 23
Mucosa, gastric, autoplastics of (abs), 486
gastric, roentgen relief (abs), 486
intestinal, impregnation methods of (abs), 306
researches on roentgen examination of (abs), 124
Mucous membrane, oral, action of roentgen rays and radium on, 151
roentgen studies of, as aid in diagnosis of peptic ulcer, 74
Myeloma, osseous, roentgen study of certain types of (abs), 131
Myomas, treatment at Würzburg University Gynecological Clinic from 1923 to 1928 (abs), 331
Myositis ossificans, case of progressive (abs), 312

Neck, treatment of metastatic involvement of, secondary to intraoral cancer, 20
Necrosis, subchondral, multiple manifestations, 861
Negatives rich in contrast, new process for making of ideal harmonic prints from (abs), 785
Nervous tissues, radiosensitivity of (abs), 143
New-born, empyema of (abs), 483
Nitrogen excretion in urine after roentgen and radium irradiation (abs), 775

Ollier's disease, 428
Opaque oils in diagnosis of maxillary sinus disease, 202
Orbit, tumors of (abs), 481
Orthoroentgenography of the heart (abs), 304
Os calcis, diagnosis, pathology and treatment of fractures of (abs), 635
Ossification (abs), 636
centers of, and period of union, diagrammatic chart showing their time of appearance, 905
Osteitis deformans, generalized, with secondary malignant degeneration (abs), 313
fibrosa cystica, of region of hip joint (abs), 491
Osteochondritides, inorganic blood chemistry in (abs), 127
Osteodystrophy, deforming (Paget's disease), some cases of (abs), 314
Osteogenesis imperfecta infantilis (abs), 314
Osteomyelitis, of pubic bone, *Staphylococcus albus* septicemia with (abs), 128
Osteoporosis, circumscribed, of skull as early symptom of Paget's disease (abs), 489
circumscripta Schüller, a rare but typical form of Paget's disease (abs), 489
Ovary, histological study of action of roentgen rays on, during period of ovogenesis (abs), 144

Paget's disease: See also Osteodystrophy, deforming
circumscribed osteoporosis of the skull as an early symptom of (abs), 489
knowledge of (abs), 490
osteoporosis circumscripta Schüller as a manifestation of (abs), 489
relation of Recklinghausen's disease to (abs), 490
Pancreas, action of roentgen rays and radium on, 495
Pellegrini-Stieda's disease: See also "Stieda fracture"
a case of (abs), 129
roentgen study (abs), 129
Pericarditis with effusion (abs), 918
Perineal route, irradiation by (abs), 138
Perthes' disease, roentgen appearance (abs), 314
Petrous bone, roentgen study of technique of examination, anatomy and symptomatology (abs), 298
Pharynx, cancer of (abs), 320
Phosphorus, roentgen changes in rickets following administration of (abs), 126
Physiotherapy in treatment of poliomyelitis (abs), 776
Plants, microchemical and cytologic findings in tissues of, irradiated by roentgen rays (abs), 142
Pleura, calcified hematic cyst of (abs), 303
Pneumatocele, case of intracranial, post-traumatic, of frontal region (abs), 299
Pneumoconiosis, review of, 556
Pneumonia, early lobar, roentgen studies, 691
Pneumothoraces, localized, as cause of annular shadows in roentgenograms of chest (abs), 916
Pneumothorax, pulsation of heart in (abs), 484
Pneumoventriculography in two cases of brain disease (abs), 299
Poliomyelitis, physiotherapy in treatment of (abs), 776
Polyarthritis, primitive symmetrical, of chronic, progressive and destructive evolution in twin sisters (abs), 318
Polycythemia vera, radiation therapy of (abs), 329
Polyposis of intestine, relation of colitis to, 834
Porter, Charles Allen, obituary notice (E), 281
Precancerous lesions of the colon, diagnosis (E), 766

PREGNANCY, position of appendix and cecum during (abs), 306
PRINTS, ideal harmonic, new process for making, from negatives rich in contrast (abs), 785
PROTECTION against roentgen rays during administration of deep roentgen therapy (abs), 785
against x-rays, 436, 911
of radiologist during roentgenoscopic examination (abs), 785
rules, German, thicknesses of protective lead in (abs), 784
PRURITUS, diabetic, treatment by functional sympathetic radiotherapy (abs), 327
vulvar, treatment by functional sympathetic radiotherapy (abs), 327
PSITTACOSIS (abs), 302; (abs), 303
PYELOGRAPHY: See also Urography
intravenous (abs), 308
intravenous, experimental study of, in pathologic conditions of kidney (abs), 309
PYELONEPHRITIS, modifications of rhythm of evacuation of pelvis in (abs), 126

QUANTUM ENERGY, average (abs), 143

RADIOLOGY, as a medical specialty (abs), 777
Institute of, University of Montevideo, consideration of 1302 cases of cutaneous epithelioma treated at (abs), 319
relation of AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY to development of, 523
RADIOTHERAPY, experience with, combined with isamin-blue (abs), 637
experimental and clinical literature on (E), 103
RADIUM, burns from, 890
detection and estimation in living persons, normal elimination, 265
Institute of, of University of Paris, Radiophysiologic and medical sections (abs), 133
intensity of gamma radiation at surface and immediately around needles containing (abs), 322
irradiation, significance of time factor in (abs), 139
rays, weakening of, by walls and floors of buildings (abs), 783
therapy, dosimetry in (abs), 775
therapy, measurement at the surface (abs), 328
RADON, simple apparatus for purifying, 630
RECKLINGHAUSEN'S DISEASE, relation of, to Paget's bone disease (abs), 490
RESPIRATORY TRACT, upper, roentgenology (abs), 301
RESPIRATORY MOVEMENTS, method of recording on a single roentgenogram (abs), 920
RHEUMATISM, chronic, of joints, grand syndromes (abs), 317
RICKETS, roentgen changes in, following administration of phosphorus (abs), 126

ROENTGEN, burns, deep, 890
examination in technology (abs), 140
examinations, 4,600 made in six years (abs), 637
irradiation with Coutard's protracted fractional roentgen irradiation (abs), 333
monument to, in Lennep, 475
plates and films, historical evolution of, 540
rays, biological dosage unit for (abs), 778
rays, their significance in science and technique (abs), 779
science, contributions of a quarter century of electron physics to, 528
tube currents and voltages, methods of measuring and recording, 871
unit, reproducibility of (abs), 777
ROENTGENIANA, early American, 549
ROENTGENOGRAPHY, serial, accessory for, in peptic ulcer, 289
ROENTGENOLOGICAL CONFERENCE, 911
ROENTGENOLOGY as a specialty, 821
contribution of, to medicine and surgery in the last twenty-five years, 511
development of, in Austria (abs), 776
ROENTGENOSCOPIC DARK ROOM, fluorescent chalk and illuminator for roentgenograms for, 629

SALIVARY GLANDS, action of roentgen rays and radium on, 156
SALPINGOGRAPHY, diagnosis and treatment of case of hydrops tubae profluens by (abs), 331
SARCOMA, idiopathic hemorrhagic, roentgen treatment, 260
indications for radiotherapy of (abs), 138
of uterus, roentgen therapy (abs), 331
Rous chicken, tumor-inhibiting substance in, 750
SCURVY, clinical and roentgen manifestations in seven-year old child (abs), 633
SEMILUNAR BONE, malacia of (abs), 312
SENSITIZATION by means of roentgen rays (abs), 779
SHOULDER GIRDLE, anomaly of (abs), 312
SINUS, maxillary, use of opaque oils in diagnosis of disease of, 202
nasal, roentgenographic and clinical observations, 214
nasal, use of iodized oil in diagnosis of conditions of (abs), 300
paranasal, roentgen examination (abs), 300
SKELETON, changes in, in tabes dorsalis (abs), 315
SKIN, carcinoma, results of treatment in 152 cases, 881
human, studies of roentgen erythema of (abs), 319
SKULL, circumscribed osteoporosis of, as early symptom of Paget's disease (abs), 489
method for roentgen dissociation of superimposed shadows (abs), 298
roentgenographic anatomy of (abs), 914
study of base of (abs), 116

tumors (abs), 914
Sphincter of Variolius, insufficiency of, on giving an opaque enema (abs), 489
Spina bifida of the atlas, knowledge of (abs), 634
Spinal column, cervical, roentgen demonstration of hypertorsion in child's (abs), 312
Spinal cord, diagnosis of tumors involving (abs), 309
Spleen, roentgen visualization of, following injections of halogenated oils (abs), 780
Spondylarthritis, ankylopoetic (abs), 317
Spondylitis, tuberculous, paravertebral abscess as an early sign of (abs), 127
Spondylolisthesis (abs), 634
Sputum, asbestosis bodies in (abs), 301
Staphylococcus albus septicemia with osteomyelitis of pubic bone (abs), 128
Stenosis, aortic, with calcification of the cusps (E), 468
pyloric, early case of (abs), 124
"Stieda fracture," on question of so-called (abs), 130
Stomach, action of adhesions on, and duodenum (abs), 485
action of roentgen rays and radium on, 167
bilocular, roentgen study of (abs), 304
diverticula (abs), 305
gastroduodenal ulcer and cancer, gastric retention and dilatation in (abs), 306
mucosa, autoplastics of (abs), 486
mucosa, roentgen relief of (abs), 486
multiple adenopapillomata of (abs), 920
snail-shaped rolling in of (abs), 486
thoracic, 899
type of snail-shaped retraction of the pars pylorica which may simulate carcinoma (abs), 485
ulcerous cicatrized hour-glass, instructive filling and outlining of carcinoma niche in (abs), 487
Strangulation obstruction, evaluation of x-ray evidence as a criterion of (abs), 781
Streptococcus, infections with, in epiphyses and short bones (abs), 315
Streptothricosis (abs), 916
Sympathetic system, case of lichen planus cured by roentgen irradiation of (abs), 135
cutaneous, keratodermia treated by irradiation of (abs), 136
radiotherapy of, in certain cardiovascular affections (abs), 134
treatment of radiotherapy of, in diabetic pruritus (abs), 327
treatment of radiotherapy of, in vulvar pruritus (abs), 327
Syphilis, congenital, value of roentgenography in diagnosis, 96
interstitial pulmonary (abs), 302
Syringomyelia, roentgen therapy (abs), 319

Tabes dorsalis, changes in skeleton in (abs), 315
Tarso-metatarsal articulation, first, roentgen appearance in hallux valgus (abs), 635
Technology, roentgen examination in (abs), 140
Teeth, action of roentgen rays and radium on, 153
Teleroentgenography of heart and great vessels, technical point (abs), 786
Temporomandibular joint, 624
studies on, 452
Teratoma, mediastinal, in an infant (abs), 918
Thorax, actinomycosis of (abs), 483
recognition of calcification in, 191
rounded opacities of (abs), 121
Thorium nitrate, sensitization effect of (abs), 779
Thymus (abs), 919
in infancy, roentgenology of, and differential diagnosis (abs), 123
Thyroid, carcinoma, skeletal metastasis in (abs), 310
Thyrotoxicosis, results of radiotherapy (abs), 328
Tibia, endothelioma of (abs), 491
Tongue, cancer, radium and surgery in (abs), 136
cancer, radium treatment of (abs), 137
Tuberculosis: See also Epituberculosis
course of, in lungs (abs), 118
childhood, roentgen aspects, 397
experimental, roentgen-ray treatment, 716
miliary of iris, two cases cured by radiotherapy (abs), 320
of adnexa, roentgen therapy (abs), 332
of bone, healing in (abs), 315
of larynx, roentgen findings in (abs), 301
of lobe of lung, clinical and roentgen study (abs), 482
pulmonary, roentgen-anatomic studies of colon in 600 patients with, 704
subacute miliary (abs), 121
survey of, in schools of Colorado (abs), 917
Tumor-inhibiting substance in Rous chicken sarcoma, 750
Tumors, brain, roentgenography, 414
endometrioid, of ovary and peritoneum, temporary roentgen amenorrhea in (abs), 333
melanotic, of the skin, treatment, 236
metastatic and primary bone, changes in, following various doses of roentgen rays (abs), 326
of orbit (abs), 481
of skull (abs), 914
of spinal cord, diagnosis (abs), 309

Ulcer, gastric, early recognition of, and carcinoma, by roentgen ray (abs), 123
gastric, value of negative roentgen findings in diagnosis of (abs), 487
gastroduodenal, gastric retention and dilatation of stomach in (abs), 306
peptic, an accessory for serial roentgenography in, 289

peptic, of the esophagus, 696
peptic, roentgen studies of mucous membrane as aid in diagnosis, 74
ULTRAVIOLET MEASUREMENT with cadmium photoelectric cell, 272
UMBRATHOR used in visualization of intestinal mucosa (abs), 306
URETHRA, female, roentgen examination, especially in cases of prolapse and incontinence (abs), 308
URINARY INCONTINENCE, postoperative (abs), 126
URINE, nitrogen excretion in, after roentgen and radium irradiation (abs), 775
UROGRAPHY: See also Pyelography
by uroselectan (abs), 125
intravenous (abs), 309
intravenous, by sodium salt of 5-iodo-2-pyridon-N-acetic acid (abs), 309
UTERUS, adeno-epitheliomas of, results of radiotherapy (abs), 132
carcinoma, bacterial flora in, after treatment with radium (abs), 322
cervix, cancer, radiation therapy at Bellevue Hospital, 746
cervix, carcinoma, technique of treatment, 734
cervix, study of microbic flora of epitheliomas of (abs), 132
fundus, carcinoma, radium as an adjunct to surgery in treatment of, 738
sarcoma, roentgen therapy (abs), 331

VASCULAR TREE, changes in, following experimental sympathetic ganglionectomy (abs), 319
VERTEBRAE, significance of some changes in bodies of (abs), 316

WARTHIN, ALDRED SCOTT, obituary notice (E), 279
portrait opposite page 279
WHOOPING COUGH, radiotherapy (abs), 328

X-RAY PROTECTION, 436, 911

YEAST, activation of, by x-ray and other radiation (abs), 780
infection of lungs, 408

AUTHOR INDEX TO VOLUME XXVI

Abehouse, Benjamin S., 126
Ackerman, S., 328
Ackman, F. D., 920
Adams, W. E., 781
Adelstein, Leo J., 915
Agati, Dino, 492
Alajouanine, Th., 316
Alberti, W., 487
Albrecht, Hans, 333
Allen, Bundy, 214
Allison, Nathaniel, 771
Alonso, Justo M., 320
Altschul, Walter, 452
Ané, J. N., 779, 780
Anspach, Brooke M., 754
Anzilotti, A., 305
Asti, Mario Luigi, 328
Aurelius, J. Richards, 696
Bachmann, A., 317
Bagg, H. J., 752
Balestra, Giovanni, 298
Ballon, Harry C., 916
Bargen, J. Arnold, 834
Barker, Walter C., 777
Bartlett, Edwin I., 130
Bazemore, M. K., 917
Beau, Henri, 134
Béclère, Antoine, 331
Beeler, Raymond C., 202, 220
Behnken, Hermann, 777
Belot, J., 121, 304
Benjamin, Bernard, 302
Benner, Sven, 783
Berg, Richard N., 636
Bergerhoff, W., 302
Berry, G. P., 302, 303
Bienvenue, A., 327
Birkett, G. E., 136
Bishop, Paul A., 625
Bivings, Lee, 128
Björling, E., 778
Blackberg, S. N., 779, 780
Bland, P. Brooke, 755
Boas, Harald, 313
Bogan, M. E., 123
Böhler, Lorenz, 635
Bolaffio, Michael, 328
Boldingh, W. Hondius, 141, 784
Bonanno, A. M., 322
Bouchacourt, L., 785
Bowen, David R., 903
Bowing, Harry H., 738, 757
Brams, William A., 123
Brednow, W., 486
Briggs, D. R., 780
Bromer, Ralph S., 428
Brown, Percy, 281
Brunschwig, Alexander, 315
Buchman, Joseph, 127
Burgheim, F., 329
Butler, Carlos, 319

Cade, Stanford, 137
Cailliau, F., 299
Camp, John D., 905
Camplani, Mario, 315
Carmack, J. W., 212
Carty, John R., 629
Case, James T., 511
Caspari, W., 786
Caulfield, Ernest, 124
Chamberlain, W. E., 777
Chantraine, H., 141
Chantriot, 136
Chantriot, Pierre, 135
Chavany, J. A., 143
Chêne, P., 120
Christian, Henry A., 767
Christie, Arthur C., 523
Cilley, Earl I. L., 905
Clark, George L., 528
Clark, Stanley, 459
Cohn, Isidore, 481
Cola, Guiseppe, 491
Coldwater, K. B., 781
Cole, L. G., 302
Cole, W. G., 302
Collins, James N., 202, 222, 260
Compere, Edward L., 126
Conte, Ettore, 314
Cooper, H. K., 710
Coste, F., 317
Courville, Cyril B., 915
Craig, Winchell McK., 319
Cramer, H., 637
Crane, A. W., 92, 95
Craver, Lloyd F., 329

Dale, T., 313
Davis, John Staige, 890
Day, Lois, 315
de Schlanger, Enriquetta W., 329
Delherm, 319
Delherm, L., 134
Delrez, L., 307
Desjardins, A. U., 145, 335, 493, 639, 787, 919
Dhikéos, 304
Diacicov, Mihail, 320
Didiée, J., 299
do Amaral, Zephirino, 319
Donaldson, Malcolm, 321
Dorrance, George M., 44
Downs, E. E., 459
Dragulescu, I., 124
Drevon, 303
Duhem, P., 776

Edmondson, John H., 465
Edsall, Katharine S., 47
Emperaire, 303
Ennis, LeRoy M., 112
Epstein, Jacob, 483
Ericksen, Lester G., 881
Erskine, Arthur W., 456, 460, 478
Evans, William A., 236, 259
Eymer, H., 332

Failla, G., 265
Falcoz, 126, 135
Farrior, J. Brown, 220
Feci, L., 301
Feldman, Maurice, 123
Fenger, I., 315
Fischgold, H., 318
Fleurant, 306
Forbes, Roy P., 917
Freund, Ernst, 314
Fricke, Robert E., 738
Friedman, Eugene, 633
Fuchs, Arthur W., 540

Gabriel, Gerhard, 309
Gál, Felix, 638
Gally, 304
Gally, Léon, 306
Ganzoni, M., 325
Garcia-Calderon, J., 124
Gasul, Benjamin M., 119
Geipel, P., 634
Genner, Viggo, 313
Gershon-Cohen, J., 414
Geyman, Milton J., 868
Gfrörer, O., 778
Ghormley, Ralph K., 771
Gittleman, Isaac F., 127
Glaser, Jerome, 483
Glasser, Otto, 475
Glocker, R., 779, 784
Goehl, R. O., 780
Goldberg, Benjamin, 119, 397
Goldbloom, A. Allen, 74
Golden, Ross, 47
Goldstein, Albert E., 126
Goldstein, Dn., 491
Good, Louis P., 483
Goodyear, Henry M., 300
Gouin, J., 327
Granger, Amedee, 300
Gricouroff, Georges, 144
Grier, George W., 23, 221, 461, 466
Gross-Albenhausen, 491
Guénaux, G., 306
Gutmann, René A., 307

Habliston, Charles C., 120
Haenisch, George Fedor, 821
Halpert, Béla, 704
Hammerschlag, Sigfrid, 330
Hanson, M. B., 127, 315
Hart, Alan L., 371
Hartman, Joyce I., 633
Haudek, Martin, 485
Hawley, S. J., 232
Hazen, Henry H., 772
Headland, C. I., 302
Healy, T. R., 408
Healy, William P., 734, 757
Hefke, Hans W., 681
Held, I. W., 74
Henderson, G. H., 630
Herendeen, Ralph E., 326
Heublein, Arthur C., 41
Heyman, James, 333
Hillemand, P., 120
Hirsch, I. Seth, 125
Hoffmann, F., 915
Hoffmann, Victor, 626
Holfelder, H., 627
Holmes, George W., 477
Holthusen, H., 627
Holzknecht, Guido, 776
Horton, Bayard T., 319
Hsieh, C. K., 311
Huet, J.-A., 133, 330, 331
Huguet, 303
Hurxthal, Lewis M., 123

Imbert, 312
Imboden, H. M., 517
Inglis, John, 314

Jaches, Leopold, 309
Jackson, Chevalier, 303
Jackson, Chevalier L., 301
Jacoboeus, H. C., 916
Jacotot, p., 125
Jacquet, Paul, 306
Jaeger, Robert, 777
Jaguttis, P., 328
Jaubert de Beaujeu, A., 129
Jenkinson, Edward L., 899, 903
John, Rutherford L., 428
Joly, Marcel, 785
Jorstad, Louis H., 780
Jüngling, O., 627
Jung, T-Shan, 920
Juris, Kalman, 785
Juul, Jens, 139

Kahlstorf, A., 300, 333
Kamikawa, Kazuniro, 131
Kantner, 140
Kaplan, Ira I., 746
Kearby, D. O., 211
Keene, Floyd E., 756
Kehrer, E., 312
Keith, W. S., 780
Keynes, Geoffrey, 320
Kirkland, A. Stanley, 919
Kirklin, B. R., 681, 902, 908
Klason, T., 306
Klemmer, R. N., 710
Knipping, P., 779
Knospe, Heinz, 330
Ko Muro-Hide O, 142
Kraft, Ernest, 65
Kugelmass, I. Newton, 636

Lacapére, J., 317
Lacassagne, A., 132, 138
Lachapèle, A., 125
Larimore, J. W., 223
Layani, F., 128
Ledoux-Lebard, R., 124
Legal, Wilhelm, 635
Léri, A., 128
Leucutia, T., 236
Levene, George, 87
Levin, Isaac, 310
Levitt, Walter M., 111
Levyn, Lester, 904
LeWald, Leon T., 95, 902
Lewis, Fielding O., 41
Ley, Jacques, 318
Löw-Beer, Adalbert, 486
Lopez, Ramirez R., 919
Lurie, William A., 915
Lynch, F. W., 780
Lynch, Kenneth M., 301

McAlpin, Kenneth R., 47, 65
McEuen, H. B., 321
McPhedran, F. Maurice, 871
Mahar, 135
Maino, Mario, 141
Malugani, Pietro C., 482
Martin, Charles L., 63
Martin, Frederick C., 540
Martin, Hayes E., 28
Martin, W. C., 861
Martius, H., 627
Mathey-Cornat, M., 131
Mayers, Laurence H., 317
Meland, Orville N., 20
Menard, O. J., 123
Menville, L. J., 779, 780
Meyer-Borstel, H., 489, 490
Meyerding, H. W., 634
Michelson, Gabriele, 130
Miescher, G., 325
Milani, Eugenio, 138
Miller, Garrett R., 191
Monod, Octave, 132
Montanari, Arrigo, 914
Morel-Kahn, 319
Morrison, L. B., 408
Morse, R. W., 302
Munteanu, V. I., 320
Murdoch, J., 775
Mutscheller, A., 142
Muzii, Mario, 637

Naujoks, H., 785
Nebout, J., 304
Neill, William, Jr., 40
Nell, W., 775
Nikiforov, P., 491
Nikitin, S. A., 779
Norris, Charles C., 753
Nuvoli, Umberto, 914

Oreggia, Juan C., 320
Ottaviani, Gaetano, 484
Overman, F. V., 210

Pack, George T., 329
Palugyay, Josef, 478
Pancoast, Henry K., 42, 64, 123, 301, 556, 911
Parenti, Silvio, 300
Paris, M., 307
Pausdorf, Hans, 775
Payenneville, J., 299
Peirce, Carleton B., 839
Pendergrass, Eugene P., 556
Perona, Pietro, 484
Perotti, D., 316
Peterson, C. H., 328
Petit-Dutaillis, D., 316
Pétrignani, Roger, 129
Peuteuil, G., 121
Pfahler, George E., 39, 64, 116, 257
Phemister, D. B., 315, 782
Piccinino, Guido, 487
Pietrantoni, L., 301
Podkaminski, 304
Pohle, Ernst A., 319
Polano, O., 331
Pondé, Adriano, 312
Porro, N., 312
Porta, Remo, 917
Portmann, U. V., 458
Potter, Hollis E., 107, 289
Pound, R. E., 302
Prévôt, R., 306

Quick, Douglas, 45, 136

Radu, E., 328
Ratti, A., 298
Raynal, Albert, 137
Regaud, Cl., 133
Reynolds, Lawrence, 103, 277, 616, 766
Rhoads, C. P., 303
Rieder, H., 487

Rigler, Leo G., 127
Rivers, T. M., 302, 303
Robb, Charles, 321
Roesler, Hugo, 861
Roffo, A. H., 919
Rubin, Eli H., 118
Ruckensteiner, E., 771
Ruggles, Howard. E., 477

Sabatini, Gioacchino, 489
Sachs, Ernest, 477
St. Gavrilescu, 320
St. Simon, 306
Saito, Makoto, 131
Samek, Julius, 324
Sampson, Homer L., 704
Sandera, Robert, 485
Sante, L. R., 903
Santoro, Mario, 299, 300
Schall, L., 915
Schinz, H. R., 627
Schlanger, Pablo, 329
Schlundt, Herman, 265
Schmitz, Henry, 320, 753
Schmorl, G., 490
Schneider, Leo V., 916
Schultze, Gunter K. F., 775
Schwarzschild, M. M., 272
Seitz, L., 332
Sharp, George S., 28
Sievert, Rolf M., 322, 784
Silveira, José, 303, 312
Simmons, Channing C., 5
Singer, J. J., 916
Sittenfield, M. J., 750
Skinner, E. H.. 459, 549, 759
Smith, Lester A., 202
Smitth, W. Atmar, 301
Snoeck, J. J., 318
Snoke, Paul O., 710
Sobel, A., 133, 330, 331
Soper, Willard B., 483
Soules, F., 120
Speed, Kellogg, 636
Spiegler, Gottfried, 785
Spies, John W., 309, 716
Steel, David, 66, 468
Stenstrom, K. W., 881
Stevens, R. H., 258
Stewart, Fred W., 1
Strauss, Herman A., 123
Surmont, J., 786
Sussman, Marcy L., 894
Sutton, Lucy P., 918
Swick, Moses, 309

Takemura, K., 264
Talia, F., 489
Taussig, Lawrence, 44
Taylor, Lauriston S., 451
Thomas, Harold, 878
Thomsen, Einar, 308
Thoraeus, Robert, 784
Trout, Hugh H., 328
Truchot, 126
Turano, Luigi, 141

Ude, Walter H., 127, 691
Uebel, Paul, 331
Uhr, J. S., 121
Ullmann, Henry J., 323, 726

Van Allen, C. M., 920
van der Tuuk, J. H., 784
Vallebona, A., 298, 484
Vancea, P., 117
Vasselle, P., 306
Vastine, Jacob H., 464, 912
Verploeg, Ralph, 917
Vinzent, René, 132
Vogt, Edward C., 96
von Hecker, H., 306
v. Kemeri, Dezsö, 327
von Lichtenberg, A., 308

Walther, H. E., 302
Wangensteen, O. H., 488, 780
Warner, W. P., 916
Warren, S. Reid, Jr., 871
Weatherwax, J. L., 321
Webb, C. H., 488
Weill, J., 128
Weiss, Konrad, 489
Weller, Carl V., 280
Westermark, N., 916
Weyl, Charles, 871
Widmer, H., 325
Widmann, Bernard P., 12, 729
Wilcox, Herbert B., 918
Wollstein, Martha, 918
Woltman, Henry W., 309
Worms, G., 299
Wright, Cecil S., 319

Yanagizawa, Hideyoski, 131

Zimmern, A., 143
Zucoli, 303
Zuppinger, A., 333

VOLUME XXVI DECEMBER, 1931 NUMBER 6

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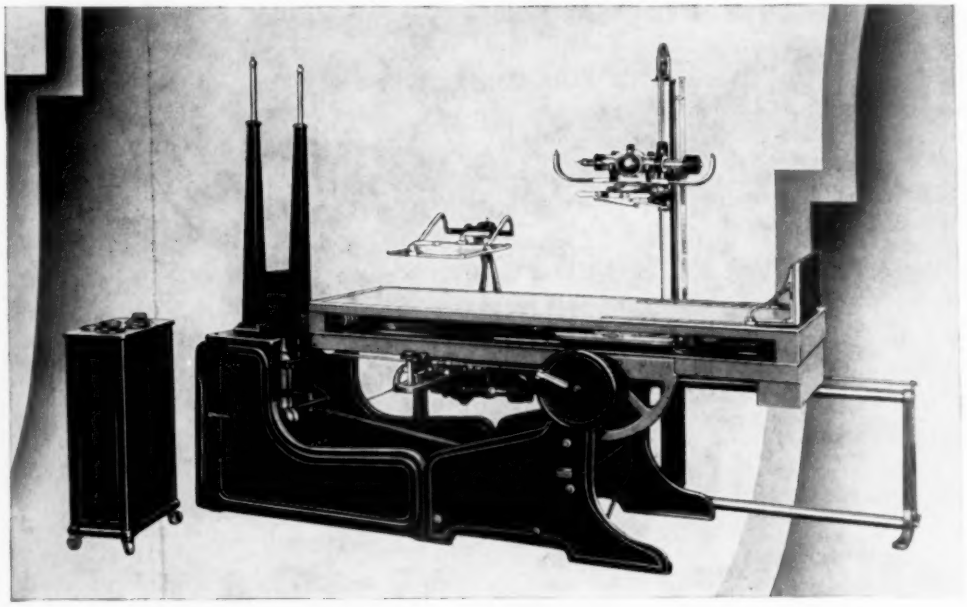

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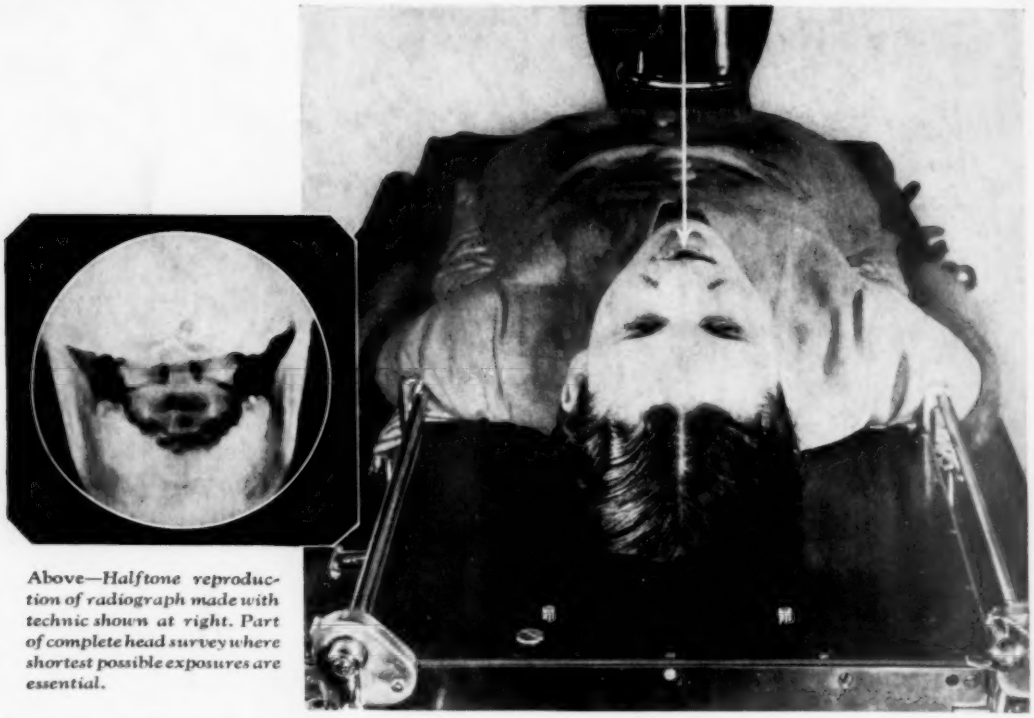

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